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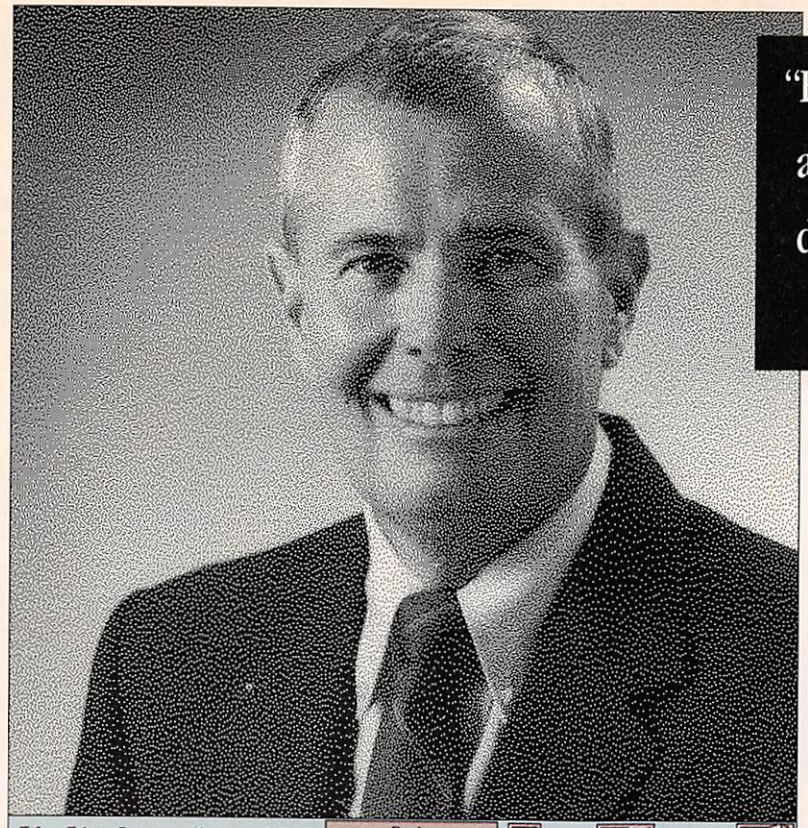

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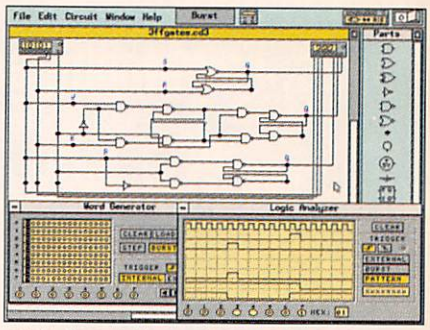

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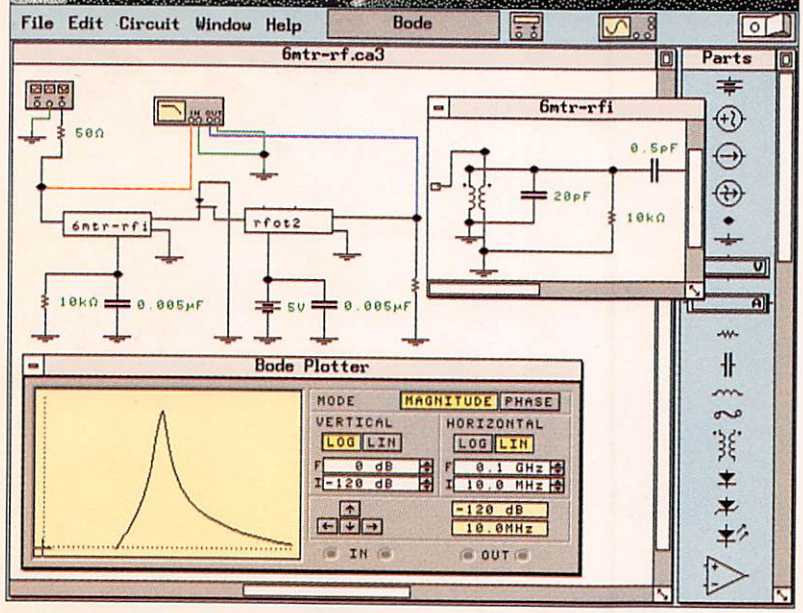

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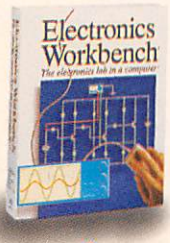

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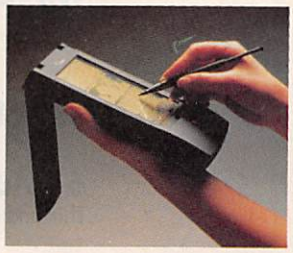

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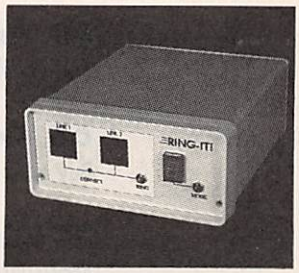

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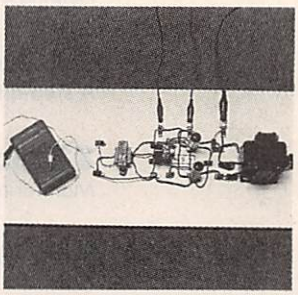

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EDITORIAL

HOBBYISTS AND SMT

By now, most readers of this magazine are familiar with the revolution in electronics assembly called "Surface-Mount Technology." If you are not, and if you are like most hobbyists, let me tell you now that you are going to hate it.

Developed to make automated assembly of electronics devices and products easier, quicker, and more reliable, surface-mount technology is a manufacturer's dream-come-true, but can be a hobbyist's nightmare. PC-boards without holes, tiny rice-grain-sized components, and ultra-compact component spacing are just some of the "features" of SMT. Add to that the fact that many surface-mount components are available only on reels or in strips, and not in quantities of one or two, and it's almost enough to drive one to take up knitting instead.

But don't despair! Things are not as bad as they look at first glance. Surface-mount circuitry can be assembled using pretty much the same tools and materials you presently use, although you will have to learn some new techniques. What's more, as SMT gains in popularity, more and more distributors are adding items to their product lines, and at prices that are affordable to the majority of hobbyists.

As with every change in technology, there are going to be hobbyists who will rage against surface mount. Unfortunately, if industry dictates the change, hobbyists will either have to adapt, or eventually become extinct. Personally, I don't intend to go the way of the dinosaurs.

If you agree, and want to learn what you need to know to become a successful surface-mount hobbyist, check out "A Hobbyist's Guide to Surface-Mount Technology." That article gives you the information you need to make the transition, including some background on the different surface-mount components available; the techniques, tools, and materials you need to do surface-mount assembly; and a list of sources that sell surface-mount components in quantities and prices that are reasonable for hobbyists. The story begins on page 45.

Carl Laron
Editor

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LETTERS

AC OR DC OMISSIONS

Congratulations to James P. Rybak on his account of the war of the currents, "AC or DC" (**Popular Electronics**, September 1994). However, his omission of Nikola Tesla's part in the history of AC development remains a mystery. Prior to Tesla, AC transmission lines carried single-phase currents and were limited to lighting. There was no self-starting induction motor for power. Tesla's polyphase patents changed all that. The Westinghouse Company gained the edge when it purchased the Tesla patents.

Also omitted in Rybak's account was General Electric's attempt to circumvent the Westinghouse polyphase patents. It was only through cross-patent agreements that GE was able to get in on the breakthrough in AC developments.

The omission of the name Tesla as well as the word polyphase in a history of alternating current development is unacceptable. Lord Kelvin, the famous British physicist, stated that "Tesla had contributed more to electrical science than any man up to his time." Pretty strong talk when considering the long list of giants in this field of engineering. However, other leaders in electrical engineering made similar public statements. B.A. Behrend, who did so much work with AC and induction motors, stated that without "Tesla's work, the wheels of industry would cease to turn . . . our towns would be dark, our mills would be dead and idle." H.G.

Queensbury, NY

50-MHz FREQUENCY COUNTER CORRECTION

I just received the November 1994 issue of **Popular Electronics**. It contained several interesting articles, including "Build a 50-MHz Frequency Counter," by Terry Weeder.

There is, I believe, an error in the schematic on page 34. It appears that the junction of R2, D1, and D2 should be grounded. The description of the input circuit, in the paragraph headed "About the Circuit," also implies that the point would be grounded.

I found all of the construction articles interesting, as I like to build test equipment and add-ons to test equipment.

B.S., CET

Hillsboro, MO

MONITORING AUTO AIR-CONDITIONERS

In the August 1994 issue of **Popular Electronics**, I found the article "Build An Air-Conditioner Monitor For Your Car" to be of interest. However, on many cars, a much simpler device can be used to warn of low refrigerant.

On most cars, a normal refrigerant charge will produce a pressure on the low side (the line from evaporator to accumulator to compressor in the article's Fig. 1) of about 35 psi, for a temperature of about 38°F with the engine idling. At driving speed, with the compressor running faster, both the pressure and the temperature will drop. To prevent freeze-up of the evaporator, the pressure switch will turn off the compressor when the pressure gets below about 25–30 psi (about 28°F). Then the pressure in the low side will rise, and the pressure switch will turn back on at about 40 psi.

Thus a simple tester can be made using only R1 and LED1, although I would increase R1 to 560 or 680 ohms. LED1 will indicate when power is applied to the compressor. At idle (stopped at a traffic signal, for instance), the compressor should seldom, if ever, cycle off. At driving speed, the rate of cycling on and off will vary, depending on driving speed, outside temperature, etc. If LED1 cycles off at idle, the air-conditioning system is almost certainly low on refrigerant.

I made a simple portable tester using a similar principle. I used a six-foot length of 22-gauge stranded zip cord (speaker wire). I attached a pair of small, insulated alligator clips to one end and a 12-volt incandescent lamp to the other. (Using an incandescent lamp instead of an LED makes polarity unimportant.) The clips can be attached to the compressor lead under the hood, and the wire routed out of the hood and in the front edge of the door to place the lamp inside the car.

On many General Motors cars, there is a two-wire plug to the compressor. Under tape next to the compressor plug is a diode connected to the two wires. The leads of the diode are a convenient place to connect the alligator clips.

Some cars do not have the pressure switch; the compressor continues to run even if the pressure is low. In that case, the complete circuit of the Air-Conditioner Monitor would be most useful. There are, however, a couple of simple checks that can be made.

First, on a warm, but not extremely hot, day, after the car has been driven for several miles with the air-conditioner on, stop the car, but leave the engine and AC running. Raise the hood. If there is any ice visible on the accumulator or the low-pressure lines from the evaporator to the accumulator or the accumulator to the compressor, the system is low on refrigerant.

The second check is to feel the low-pressure line where it enters the compressor. It will be warm if the refrigerant is low, cool if there is sufficient refrigerant. If refrigerant is being lost, the low-pressure pipe at the compressor will get warm before enough refrigerant is lost to make the low-pressure pipe warm where it comes through the firewall.

B.S., CET

Hillsboro, MO ■

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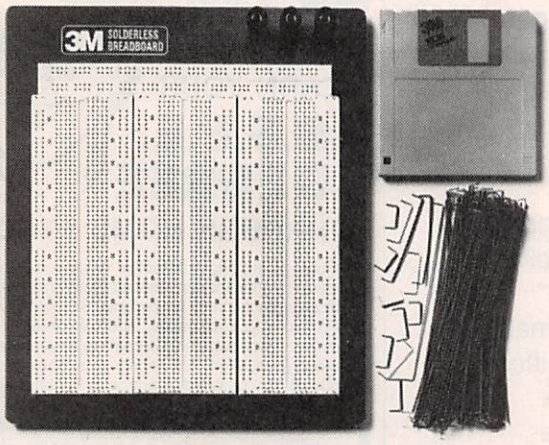

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MULTIMEDIA WATCH

By Marc Spiwak

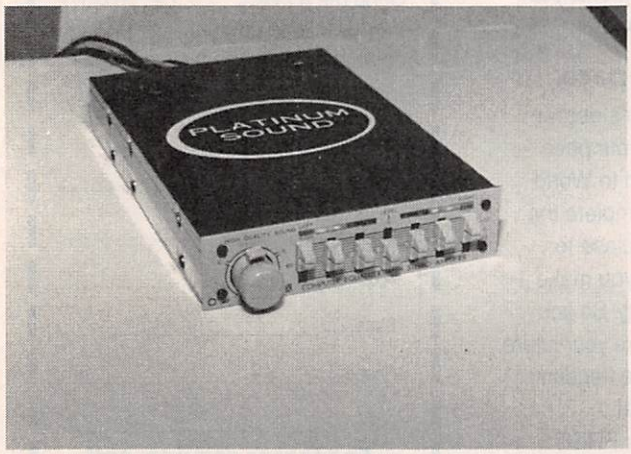
This and That

I've got a mixed bag of stuff this month, ranging from hardware to accessories to software. With so much to cover, let's get right to it.

ULTRASOUND MAX

We'll start with a new sound card from Advanced Gravis, the *UltraSound MAX*. Functionally, that card is very similar to the older Ultrasound, although many things that I considered a nuisance with the older card have been eliminated from the new one.

The original UltraSound was a 16-bit, wave-table synthesis, stereo sound card with a reasonable list price of $199—actually, that was a bargain considering the card's excellent sonic performance. By itself, the UltraSound could play back 16-bit CD-quality audio, but only 8-bit recording was possible unless an optional daughterboard, which mounted on the main board added 16-bit recording capability and more, was added to the UltraSound.



The Equalizer-Amplifier Pro is a 30-watt-per-channel amplifier/equalizer that fits into a 3½-inch drive bay.

Now, while I don't do very much recording with my sound card, I do like to have my CD-ROM drive's audio output patched directly through my sound card, so that I can control the volume level of CD audio with my software mixer. Unfortunately, the only way to do that with the older UltraSound was to buy the daughterboard, which also added the CD-ROM audio input. Without the daughterboard, those mixer controls simply could not be used. While the daughterboard was a reasonable solution, it added extra expense to the setup and also blocked an adjacent motherboard adapter-card socket. That's unacceptable in my book, especially when extra motherboard expansion slots can be so dear in a loaded PC.

The new UltraSound MAX has the daughterboard built-in, which is much better aesthetically, and functionally as well. The UltraSound MAX is a full-length card (at the time of this writing), but a half-length multilayer board is due to replace it soon. The half-length card is supposed to be functionally identical to the full-length one, and should be available by the time you read this. I'm supposed to receive a demo of the new card as soon as it's available, so I'll let you know about it as soon as I can.

Anyway, the UltraSound MAX I have now is a beauty of a sound card that's fully functional, while taking up only one slot. Separate interrupts are required for record and playback, but the new install software is improved and the card isn't difficult to get working. Sampling rates for 16-bit digital recording are normally limited to about 44 kilohertz, but the UltraSound MAX is capable of 48-kilohertz sampling for even better performance.

The card features 16 stereo digital channels that allow up to 32 voices to play at the same time. Built-in compression lets you fit more audio in less disk space. The card also features an expandable 5.6-megabyte general midi patch set with 192 instruments. Those patches remain on your hard drive until requested by software, at which point they are loaded into the card's memory. That hard-disk patch caching makes for a more professional card with great versatility; new patches can be made and stored on disk with the rest of them. As far as on-board memory goes, 512K RAM is standard, and it can be upgraded to 1 megabyte.

The card does not directly emulate a Sound Blaster, and so emulation software, included with the board, must be run to provide Sound Blaster support in DOS (Windows sound is fully supported). That used to be more of a problem. Most of the top games did (and still do) run under DOS

only, and most did not initially provide direct UltraSound support. Unfortunately, running the emulation software often caused problems, both major and minor. Today, however, most good software packages provide direct UltraSound support, which is compatible with any UltraSound, MAX or otherwise, and more are adding it all the time. With direct UltraSound support, you'll hear some of the best digital sound you've ever heard, especially for MIDI.

The card also has a few goodies that go beyond its excellent sound support. A speed-compensating joystick port is built into the card. That is a must for anyone with a fast PC, simply because the standard PC game port is too slow for today's PCs. (Unfortunately, I understand that even this speed-compensating port has speed problems with some of the new and extremely fast Pentiums.) The speed-compensating port is also available in a separate game-controller card from Advanced Gravis, but having the feature built into the sound card saves an expansion slot.

The UltraSound MAX also has three built-in CD-ROM interfaces for Mitsumi, Sony, and Panasonic drives; the card does not support SCSI devices. External connectors on the card include stereo line-in, line-out, a 4-watt amplified output, and a joystick/MIDI adapter. A full suite of audio-related software is included with the card, allowing you to do anything you want with sound. With its improved design, better software, list price of just $299, and more popular direct support, the UltraSound MAX is a sound card that I highly recommend.

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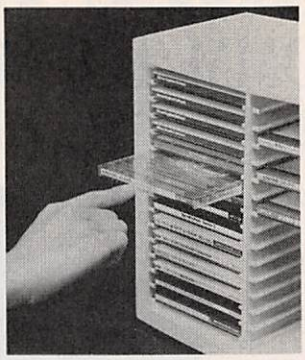
AN ACCESSORY SOURCE

Accessories are often used to solve problems or add new features to something you already have, and multimedia is an area where accessories are surely welcome. A company called SC&T² markets lots of multimedia accessories that address some common problems.

Often, when a multimedia PC is set up from scratch, there is no convenient way to adjust volume levels on amplified speakers without getting up and turning the volume control on one or both speakers, or exiting your software and adjusting a volume level from a software control panel. Sometimes a volume control is located on the back of the sound card—a location that's usually difficult to reach.

SC&T²'s *Platinum Sound Multimedia Volume Controller* is a handy little gadget that solves those problems and more, and has a list price of only $24.95. That simple device, about half the size of a mouse, mounts on the side of a monitor with double-sided tape and has a volume control knob on its face. A four-foot cable connected to the controller splits into a "Y" at the end where a stereo input plug and stereo output jack are located. The plug plugs into the output on your sound card and your speakers plug into the jack. After initially setting the volume level on your sound card and speakers, the Multimedia Volume Controller makes it easy to readjust the volume.

Amplified speakers are quite popular in the multimedia market because many sound cards have no built-in amplification, and many cards with built-in amplification don't pack much power. On the other hand, many people might want to use speakers that aren't self-amplified, or are unhappy with the amplifying power or sound quality of a pair of amplified speakers. If that last statement describes you, check out SC&T²'s *Platinum Sound Equalizer-Amplifier Pro*. That unit packs 60 watts of power (30 per channel) and an equalizer into a standard 3½-inch computer drive bay. The device will also fit in a 5¼-inch bay with an adapter.



Up to 30 discs automatically pop out of Elecom's CDR-001 at the touch of a finger.

The front panel of the unit contains a volume control, a balance control, a 7-band slide-control equalizer, and stereo LED volume-level indicators. It is easily connected to a sound card or CD-ROM drive at a back-panel plate or inside your computer. The Equalizer-Amplifier Pro runs off 12 volts DC, which it gets from your PC's (or Mac's) power supply. While many people would have no need to spend $119.95 on this device, many others could find it to be a valuable addition to their multimedia set-up. An external version is also available for $149.95.

Another problem that comes up when mixing and matching multimedia components is finding the right cable that will connect audio from a CD-ROM drive to a sound card. SC&T² markets a full line of *Platinum Sound Audio Cables* that save you the trouble of making your own. Cables are also available that allow the connection of multiple CD-ROM drives to a single sound card. Contact SC&T² for prices.

Where To Get It

Advanced Gravis
1790 Midway Ln.
Bellingham, WA 98226
Tel. 800-663-8558

AmSoft
P.O. Box 666
New Cumberland, PA 17070
Tel. 717-938-8249

Blue Mountain Software, Inc.
P.O. Box 1648
Port Angeles, WA 98362
Tel. 206-452-1251

Broderbund Software
500 Redwood Blvd.
Novato, CA 94948
Tel. 800-521-6263

Davidson & Associates, Inc.
19840 Pioneer Ave.
Torrance, CA 90503
Tel. 310-793-0600

Elecom Computer Products, Inc.
17316 Edwards Road,
Suite B-225
Cerritos, CA 90703
Tel. 310-802-0077

Grolier Electronic Publishing, Inc.
Sherman Turnpike
Danbury, CT 06816
Tel. 203-797-3500

LucasArts Entertainment Company
P.O. Box 10307
San Rafael, CA 94912
Tel. 415-721-3300

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
Tel. 206-882-8080

Multicom Publishing
1716 Locust Street
Des Moines, IA 50309
Tel. 800-850-7272

Pro CD, Inc.
8 Doaks Lane, Little Harbor
Marblehead, MA 01945
Tel. 508-750-0000

SC&T² International, Inc.
3837 Lasalle Street
Phoenix, AZ 85040
Tel. 602-470-1334

WexTech Systems, Inc.
310 Madison Ave., Suite 905
New York, NY 10017
Tel. 212-949-9595

Another multimedia problem is where to put all the CD-ROM's. SC&T²'s *CD3 Compact Disc Storage System* holds up to 40 discs (but not their jewel-box cases) on edge in a horizontal cylinder-shaped case. The case folds open at the middle with the discs resting in the bottom half. Discs fit in numbered slots and disc labels fit in numbered spaces behind a clear plastic window. A cover slides over the window. To retrieve a disc, you simply slide a selector knob to the desired disc number, open the case, and the requested disc is "stuck" to the lid, ready for you to grab. The case can also be "locked" and carried around by a folding handle that's built-in. The disc holder has a list price of about $35.

Coincidentally, I also received a new CD-ROM holder from another company called Elecom. The *CDR-001* holds up to 30 discs in their jewel boxes. What's neat is that the discs slide into slots with springs in the back. To retrieve a disc, you simply lift the front of the disc over a small lip and it pops right out of the holder and into your hand. As your CD-ROM collection grows, multiple CDR-001 holders can be ganged together side-by-side or vertically. The CDR-001 retails for $24.95.

NEW STUFF

Being that this is the first **Popular Electronics** issue of 1995, I guess I'm a month too late with news of two discs sent to me from Grolier Electronic Publishing: *The New Grolier Multimedia Encyclopedia,* and the *1994 Guinness Multimedia Disc of*

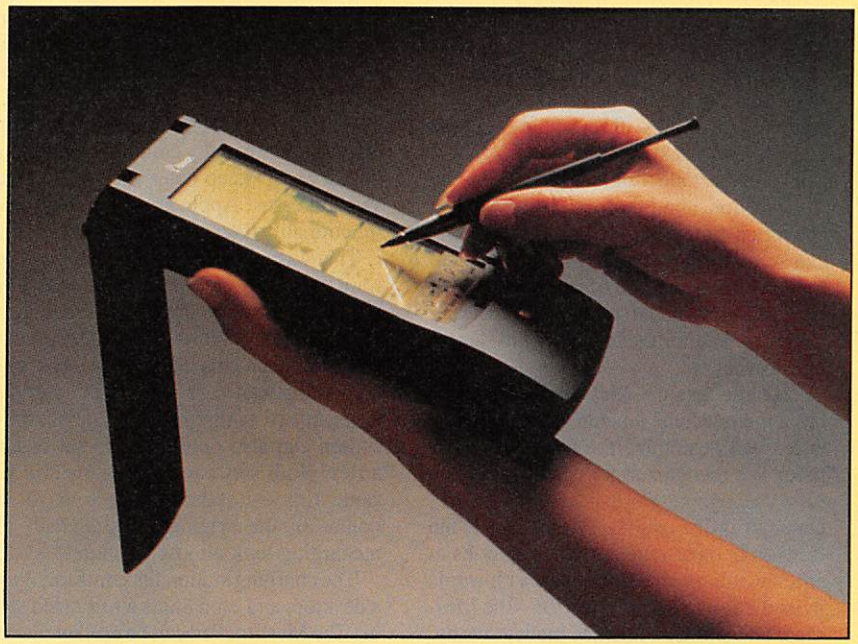
(Continued on page 92)

GIZMO®

A CHRONICLE OF CONSUMER ELECTRONICS

Apple's Newton

NEWTON MESSAGEPAD 110. Manufactured by: Apple Computer, Inc., 20525 Mariani Avenue, Cupertino, CA 95014. Price: $599.



Almost one year ago, in a special issue of **Gizmo**, we reviewed the first crop of personal digital assistants or PDA's. We were less than enthusiastic about the Sharp Newton Expert Pad, the Tandy/Casio Zoomer, and the AT&T Eo Personal Communicator. Although we appreciated the technology and vision that was evident in each one, we were ultimately disappointed with how all of the products worked.

What a difference a year makes. The Eo is already dead—AT&T closed down its Eo subsidiary in the second half of 1994. The Zoomer platform will apparently be orphaned—no product upgrades are in the works. On the other hand, *Apple Computer* has significantly improved its *Newton MessagePad* and has greatly expanded its Newton Product family of both hardware and software.

The weaknesses of the original Newton PDA were its limited memory, short battery life, awkward input, and several bugs as well. All of the product's deficiencies seemed even worse in the face of the huge amount of hype from John Scully—who has since departed Apple—that preceded the release of Newton by a couple of years. Expectations of the product's ability were so high that there was no way the real device could live up to them.

The original Newton also suffered from its high price and its inability to do very much. Few applications were available for it and its communications ability was poor. Before the MessagePad was introduced, the press was full of complaints from pundits who felt that Apple was taking too long to get the product to market. After it was introduced, the general consensus was that the product was released too soon.

Users who were unfortunate enough to purchase the original Newton can take part in an Apple upgrade program, in which the Newton MessagePad will get the same internal software as the new Newton. The upgrade costs $99, and comes with two Newton software products: The user can choose from Newton Connection Kit, Dell Crossword Puzzles, DrawPad, and Dyno NotePad.

The MessagePad 110 looks slightly different than its predecessor. It's a little slimmer, measuring 8 × 4 × 1¼ inches. It weighs just over 1¼ pounds. The best improvement in its housing is the cover, which flips up away from the screen and folds over the back—something very much like the Zoomer.

The MessagePad is still available with its original form factor as the MessagePad 100. It sells for $100 less than the MessagePad 110.

The three most important improvements that were made to the MessagePad are increased memory, improved battery life, and deferred handwriting recognition.

The size of the built-in RAM was increased by a factor of three, to one megabyte. The MessagePad also offers one PCMCIA type-2 card slot, which can be used for additional storage or for dedicated application cards.

The new MessagePad is significantly better with respect to battery life. Estimated life is as much as 20 hours in active use when alkaline batteries are used. Rechargeable nickel-cadmium cells will provide about 12 hours.

Another huge improvement made in the MessagePad is that it now allows for deferred recognition—users can take notes in electronic ink, and then go back and turn them into text. The one problem with deferred recognition is that the user doesn't get immediate feedback, and therefore doesn't learn the proper way to write. The big advantage is that you can write quickly, without worrying whether Newton will make sense of what you are writing.

The basic built-in software that comes with the MessagePad includes the Note-

pad, the Name File, and the Date Book. All entry to the device is made by writing or tapping on the LCD screen with a stylus. In the new MessagePad, the stylus is a round, telescoping plastic-tipped "pen" that stores away in a hole in the side of the unit. It's a big improvement over the one supplied with the original Newton. The stylus isn't absolutely essential, however. An ordinary pencil works well in a pinch as does a plastic capped pen—or almost anything else that won't scratch the glass. We often found ourselves even using our index finger—although more often to point to an item to select it than to actually write.

The Notepad is for keeping free-form notes and memos. It is always running when the machine is on, although it is sometimes covered by other applications. The notes can consist of letters, numbers, and even drawings. The writing can be converted into text by the recognizer, or it can be left as "electronic ink." Unlike the first Newton, the ink does not have to be converted to text immediately. Instead, it can be converted at a later time. That's an important advantage, because you don't have to worry about writing too fast and having to wait for the recognizer to "catch up" to you.

Like the original MessagePad, the 110 has a menu where you can set your preferences and customize the recognition engine. The recognizer, for example, can be set to recognize words, letters, or numbers. As in the original MessagePad, the Newton is most efficient when it looks at entire words and matches them with words in its dictionary. After practice—the MessagePad includes a practice mode—we became reasonably proficient at writing the way that the Newton wanted us to.

The MessagePad does a pretty good job of recognizing words in its dictionary if you write properly. However, if a word isn't in the dictionary, the resulting translations can be bizarre. That problem led to almost universal criticism of the original Newton. Fortunately, it is possible to add words to the Newton dictionary, so that words that you use frequently will be recognized.

Word recognition is not always desirable. For example, entering names in the Name File can be particularly cumbersome. Naturally, the Newton dictionary is not filled with surnames, so virtually every name that is entered will have to be corrected. Correcting a word consists of tapping on it to bring up a list of possible choices. If none matches, you can tap a keyboard icon to bring up a "keyboard" on which you can tap the word.

A big improvement in the new MessagePad is that if it gets a word wrong, and if the word that you want doesn't appear on the word list, you can tell Newton to reexamine the word using letter-by-letter recognition. The original MessagePad did have character-based recognition, but not like this. Here you can switch back and forth between word- and character-based recognition with a single pen tap. We found that it could often do a great job at it. The feature removes a lot of the frustration that was inherent in the original product.

The MessagePad also features a shape recognizer. When that feature is turned on, sloppy sketches are cleaned up so that circles are round, rectangles have square corners, and so on.

With the original MessagePad, we complained that we really couldn't do anything with it except keep notes and some names and addresses. Apple promised far greater functionality than it delivered in that unit.

That wasn't the case this time. The hardware and software accessories that were only a promise the first time we reviewed Newton are available in abundance now.

One convenient accessory is a charging station that can recharge the internal batteries in two or three hours. The charging station can also hold an extra set of batteries. Both sets can be recharged at the same time—it takes about four to six hours. In the original MessagePad, the recharging took almost 14 hours!

The charging station fits comfortably on a desktop, and even holds a full-sized stylus. The MessagePad can be used while it is recharging.

Perhaps the most important accessory for the MessagePad is the Newton Connection Kit. The kit consists of software that runs under Microsoft Windows, a manual, and a cable that lets you connect the Newton to your PC's serial port. (A Macintosh version is also available.) That not only lets you backup and save data, but lets you transfer data from your computer to the Newton.

Say, for example, that you want to use your MessagePad to keep a record of business contacts—contacts that you already had on a database on your PC. With the Connection Kit, you could download the names and other information into the Newton Name File. As long as the database can export in a standard delimited file (SDF) format, you can use the information.

If you add names and other information while you use the Newton portably, you can update your computer's database by exporting the information from the Newton.

The Newton Connection Kit is so important that it is virtually indispensable. In fact, much of the software that is available for the MessagePad comes on floppy disk and is installed through the Connection Kit. The Connection Kit is also valuable for backing up information, which it does automatically on each connection.

The Connection Kit allows the MessagePad to be used more efficiently. It allows programs to be loaded and unloaded from memory so that the user can make the most out of what he or she has. It also allows data to be entered in a much less cumbersome way.

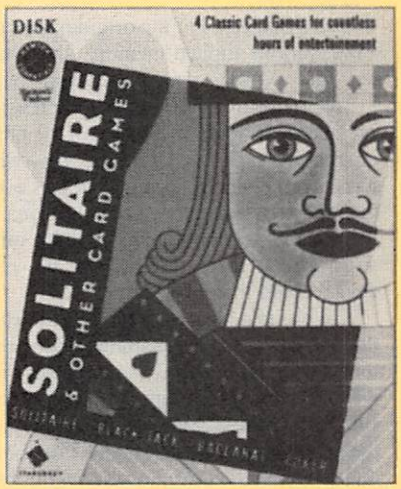
The Newton Print Pack is another essential accessory. It allows the MessagePad to print to any printer that can emulate an HP LaserJet, Canon Bubble Jet, or Epson printer. The print pack consists of a "smart" serial-to-parallel converter that has printer drivers built-in.

Another accessory that we tried was the Newton Fax modem model H0005. The shirt-pocket sized modem is powered by two AA batteries and connects to the MessagePad's serial port. It adds greatly to the functionality of the MessagePad.

Of course, all the hardware in the world is of little use if it is not accompanied by good software. Unlike our first experience with the MessagePad, software is now available. Descriptions of some of the software we examined follows. ■

SOLITAIRE AND OTHER CARD GAMES. From StarCore, Apple Computer, Inc., 5 Infinite Loop, Cupertino, CA 95014. Price: $39.95

The Solitaire package is supplied on a floppy disk, so the Newton Connection Kit is required. It offers players four different card games: traditional solitaire, blackjack, baccarat, and video poker. In all the games, money is on the line.



Built-in help explains how the games are played, which we found helpful to learn the rules of Baccarat. Unfortunately, the package is somewhat addicting—we spent far too much time playing when we

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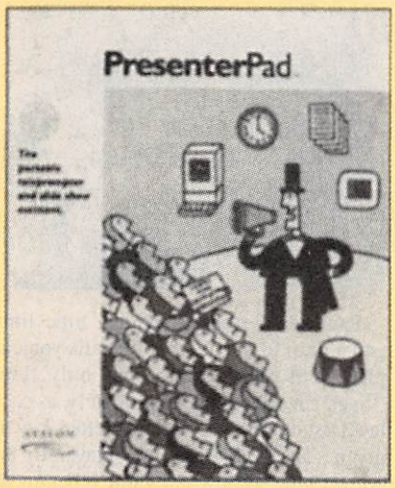
should have been working. In any case, we're glad that we weren't playing with real money! ■

PRESENTERPAD. From Avalon Engineering, Inc., 45 Newbury Street, Boston, MA 02116. Price: $89.

PresenterPad bills itself as "the world's first truly portable teleprompter." The aim of this disk-based product is to help anyone who ever speaks to a group of people to give better presentations. It has three basic functions: The Slide Manager, which is designed to help deliver presentations that are accompanied by slides or overhead transparencies; the Teleprompter, which scrolls text either manually or at a preset speed; and the Outliner, which helps to prepare and edit the information that is displayed in the Slide Manager and Teleprompter.



Gas-gauge-style indicators provide easy-to-see time information. That is particularly helpful for speakers who are constantly running out of time before the key points have been presented—or running out of words before their allotted time is up. Both the overall presentation length, and the time for each slide can be tracked.

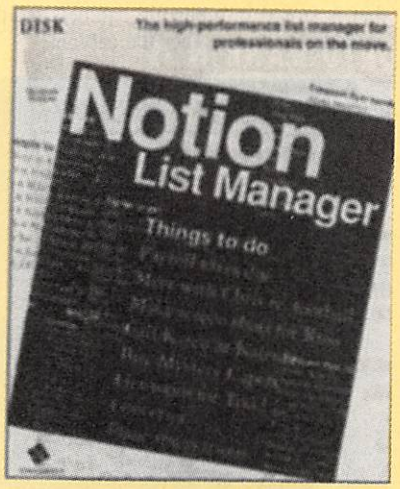
Oversized buttons allow the user to move forward or backward through the presentation—and they can be set for either right- or left-handed operation.

In the Slide Manager, key points for each slide can be displayed at once, or they can be expanded as each bullet item is discussed. It even allows presentation equipment to be controlled with Newton's built-in infrared transmitter. However, an infrared receiver is required for that feature to work. It is expected to be available later this year. ■

NOTION: THE NEWTON LIST MANAGER. From Eidetic, Inc., 15 SW Colorado Ave., Bend, OR 97702. Price: $59.

Notion allows the Newton to keep track of virtually anything from agendas and trip plans to ATM withdrawals. The list templates provided with Notion include up to fifteen different data fields for dates, flights, hotels, names, numbers, or other data.

Over 100 templates are provided with Notion. They can be used directly, or they can be modified to create new ones. Searches for information through keywords can be made through multiple lists, so you can't "lose" information that you



enter, even if you forget what list you put it in. For example, there's no need to worry if you put information about your airline tickets in your "things to buy" list instead of your "vacation planning" list. In a way, Notion becomes a value-added replacement for the MessagePad's built-in Names, Dates, and Notepad applications.

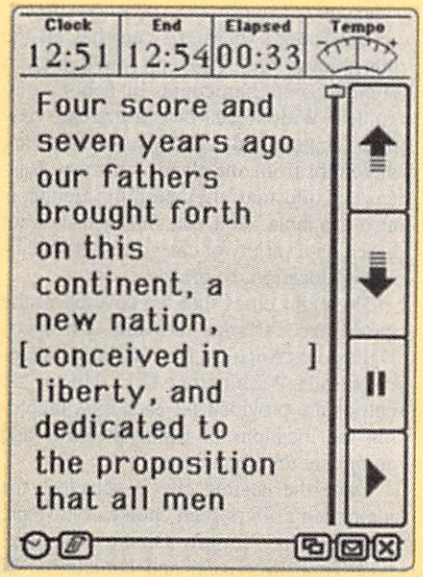
If you are someone who has to keep track of projects, expenses, or other data—or if you're just someone who loves to make lists—Notion is a package that will make the Newton MessagePad invaluable. ■

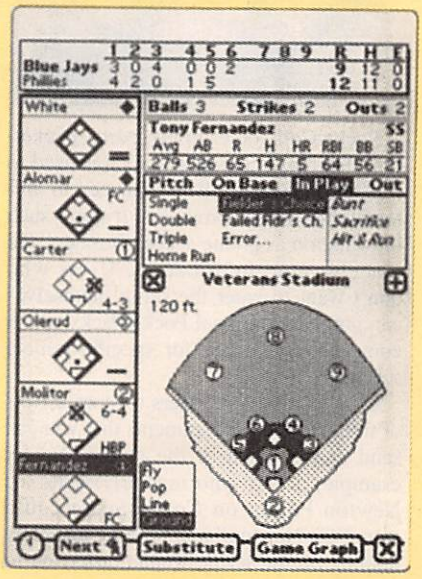
FINGERTIP FOR STATS—BASEBALL. From Fingertip Technologies, Inc., 140 Newport Center Dr., Suite 200, Newport Beach, CA 92660. Price: $129.

If you are serious about sports, you'll love Fingertip for STATS, a sports-information tool that delivers statistical analysis of every team in the majors. STATS—Sports Team and Analysis Tracking Systems, Inc.—has been a staple for baseball reporters for years. The software helps to bring the same information to Newton users.

With access to the STATS online service, you never have to worry about not having up-to-date information. Access costs $0.25 per minute; an average update requires about 4 minutes. Included in the price of purchase is two hours of online time. The software, with its mass of statistics, requires a two-megabyte storage card to install. That can be reduced somewhat by deleting, for example, the layouts of the 28 Major League stadiums.

The software's main menu offers five



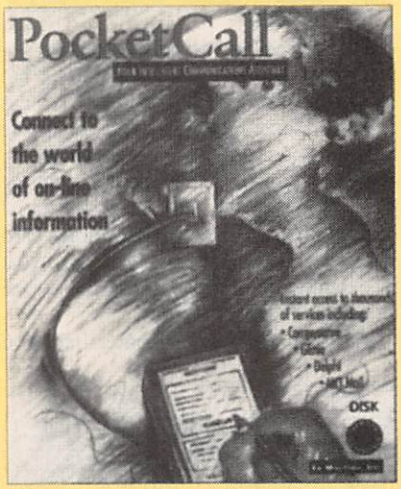


options. First is Play Ball, which provides the tools to review in-depth statistics and to track player performance while scoring a game. Second is Major League Update, which provides up-to-the-minute news stories, league standings, and analysis from around the league.

A Fantasy Favorites program allows you to review the latest stats on individual player performance while you are building your own fantasy teams. The Bill James Encyclopedia provides detailed information on the careers of all of the players in the Baseball Hall of Fame. Finally, Trivia and Tournament challenges your baseball knowledge with trivia contests as well as a daily tournament throughout the season where you can compete against others. ■

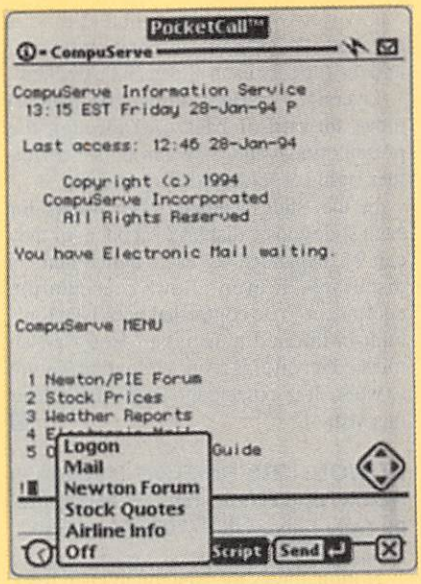
POCKETCALL. From Ex Machina, 45 East 89th Street, Suite 39-A, New York, NY 10128. Price: $149.

PocketCall is a communications program that gives the Newton MessagePad the ability to connect to any text-based online service, including CompuServe, GEnie, Delphi, MCI Mail, and many independent BBS's. It will not work with services that require proprietary graphic-based software, such as America Online and Prodigy.



PocketCall comes in two parts: PocketCall itself, and Services, which is used to configure PocketCall to connect to different information providers. It stores such information as phone access numbers and modem-setup information. Users who don't want to enter the setup themselves can purchase optional PocketPacks which come pre-configured for specific remote services.

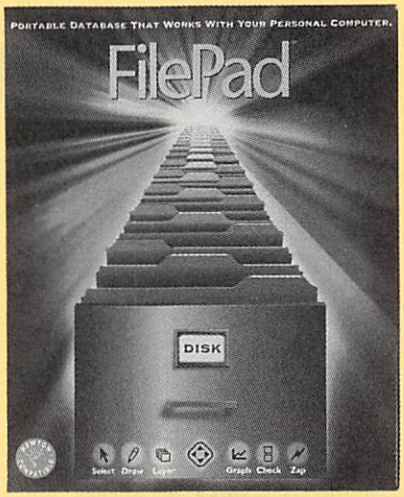
PocketCall allows users to store scripts of frequently used comments that you can send at the touch of the screen. So for example, a user who regularly visits the Newton Forum on CompuServe could store "Go Newton" and visit the forum by tapping on the script instead of having to



write (or tap the on-screen keyboard) to issue the command. ■

FILEPAD. From HealthCare Communications, 300 South 68th Street, Suite 100, Lincoln, NE 68510. Price: $139.

FilePad is a flat-file database program for the Newton. It allows users to create custom database layouts, and enter data using handwritten text, pop-up menus, and buttons. A filing-cabinet icon represents each database that is created. Data that is stored in other file cabinets is accessible from any other file cabinet.



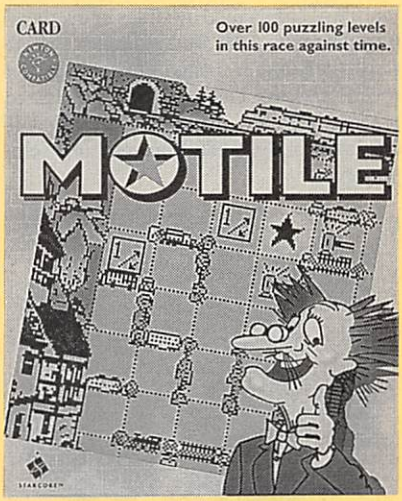
Included with FilePad is FilePad Link—computer-connection software that allows records to be transferred between the Newton and the PC. Formats that are supported include Lotus 123, Quattro, Symphony, Excel, and DBase. Data can also be output in ASCII as either tab-delimited, comma separated, or quoted strings.

Any information that is stored in FilePad can be printed, Faxed, or sent as E-mail. ■

MOTILE. From StarCore, Apple Computer, Inc., 5 Infinite Loop, Cupertino, CA 95014. Price: $59.95.

Motile is a PCMCIA card that turns the MessagePad into a challenging puzzle of mazes. The object of the game is to help Motile Moe in a race against time as he tries to reach the star in each of the mazes.

It's not as simple as it sounds. Moe follows predictable rules as he moves: He turns the corner when two walls form an "L." He bounces backward from a single wall or when walls form a "U."



Each puzzle begins with a time limit and a limit to the number of walls you can place and remove. Moe has only three "lives" in each game. Fortunately, as each level is completed, a four-letter key is given. The key brings the player to the correct level when a new game is begun. ■

FODOR'S 94 TRAVEL MANAGER: TOP U.S. CITIES. StarCore, Apple Computer, Inc., 5 Infinite Loop, Cupertino, CA 95014. Price: $119.95.

The Fodor's PCMCIA card has all the information that travelers would find in eight separate hardcopies of Fodor's city guides. Within each city, users can view their location and actually receive driving directions from one place to the next. Restaurant information, including menus, is also available. You can find a restaurant based on a variety of categories, from cuisine to location, to price.

The eight cities that are covered in the guide are: Atlanta, Boston, Chicago, Dallas, Los Angeles, New York, San Francisco, and Washington, D.C. Up to 250 entries are provided for each city, including the locations of fast-food joints and automatic teller machines.

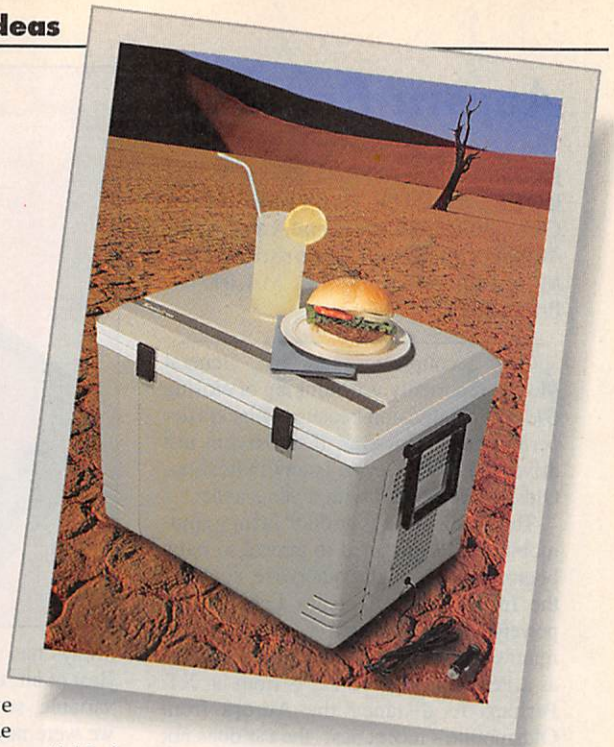
Once the desired city is selected, the main menu offers such choices as: Maps, Introduction, Airport, Dining, Lodging, Free Time, Services, and Directions. ■

TECHNOLOGY UPDATE

500 miles from nowhere, it'll give you a cold drink or a warm burger...

NASA space flights inspired this portable fridge that outperforms conventional fridges, replaces the ice chest and alternates as a food warmer.

By Charles Anton



Recognize the ice cooler in this picture? Surprisingly enough, there isn't one. What you see instead is a Koolatron, an invention that replaces the traditional ice cooler, and its many limitations, with a technology even more sophisticated than your home fridge. And far better suited to travel.

What's more, the innocent looking box before you is not only a refrigerator, it's also a food warmer.

NASA inspired portable refrigerator. Because of space travel's tough demands, scientists had to find something more dependable and less bulky than traditional refrigeration coils and compressors. Their research led them to discover a miraculous solid state component called the thermo-electric module.

Aside from a small fan, this electronic fridge has no moving parts to wear out or break down. It's not affected by tilting, jarring or vibration (situations that cause home fridges to fail). The governing module, no bigger than a matchbook, actually delivers the cooling power of a 10 pound block of ice.

From satellites to station wagons. Thermo-electric temperature control has now been proven with more than 25 years of use in some of the most rigorous space and laboratory applications. And Koolatron is the first manufacturer to make this technology available to families, fishermen, boaters, campers and hunters– in fact anyone on the move.

Home refrigeration has come a long way since the days of the ice box and the block of ice. But when we travel, we go back to the sloppy ice cooler with its soggy and sometimes spoiled food. No more! Now for the price of a good cooler and one or two seasons of buying ice, (or about five family restaurant meals), all the advantages of home cooling are available for you electronically and conveniently.

Think about your last trip. You just got away nicely on your long-awaited vacation. You're cruising comfortably in your car along a busy interstate with only a few rest stops or restaurants. You guessed it... the kids want to stop for a snack. But your Koolatron is stocked with fruit, sandwiches, cold drinks, fried chicken... fresh and cold. Everybody helps themselves and you have saved valuable vacation time and another expensive restaurant bill.

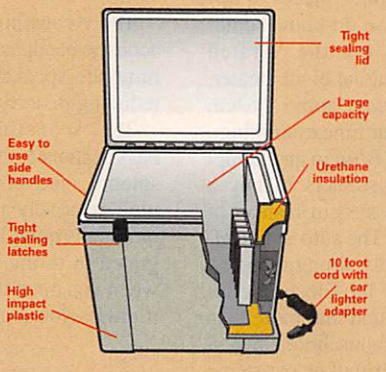
Hot or cold. With the switch of a plug, the Koolatron becomes a food warmer for a casserole, burger or baby's bottle. It can go up to 125 degrees.

And because there are no temperamental compressors or gasses, the Koolatron works perfectly under all circumstances, even upside down. Empty, the large model weighs only 12 pounds and the smaller one weighs just seven. Full, the large model holds up to 40 12-oz. cans and the smaller one holds six.

Just load it up and plug it in. On motor trips, plug your Koolatron into your cigarette lighter; it will use less power than a tail light. If you decide to carry it to a picnic place or a fishing hole, the Koolatron will hold its cooling capacity for 24 hours. If you leave it plugged into your battery with the engine off, it consumes only three amps of power.

The refrigerator from outer space.

The secret of the Koolatron Cooler/Warmer is a miniature thermo-electric module that effectively replaces bulky piping coils, loud motors and compressors used in conventional refrigeration units. In the cool mode, the Koolatron reduces the outside temperature by 40 degrees F. At the switch of a plug, it becomes a food warmer, going up to 125 degrees.



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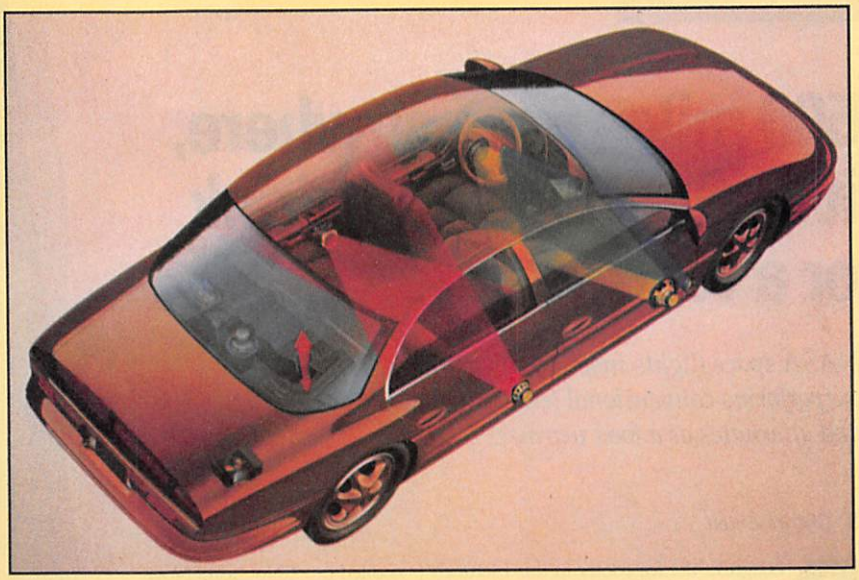
Aurora Bosealis

OLDSMOBILE 1995 AURORA WITH BOSE AUDIO SYSTEM. From Oldsmobile, 920 Townsend, Lansing, MI 48921 and Bose Corporation, The Mountain, Framingham, MA 01701. Price: $32,000.



Only a couple of years ago, General Motors reportedly was thinking of closing *Oldsmobile* division because of lackluster performance. However, if our recent test drive of a *1995 Aurora* is any indication, Oldsmobile is back with a vengeance.

The Aurora is a four-door luxury automobile that is targeted to appeal to baby boomers who might otherwise consider the Infinity J30 or Acura Legend. It's powered by a 4-liter V-8, and is as far removed from its immediate predecessors as a Pentium-powered PC is from an XT. Perhaps to distance the Aurora from Oldsmobile's recent past, the car does not have an Oldsmobile badge anywhere on its outside. The only Oldsmobile nameplate is inside, on the radio's trim.

A host of electronic goodies is supplied as standard equipment in the Aurora, including traction control, antilock brakes, and cruise control. Also included is an automatic day/night rearview mirror that helps to reduce annoying glare during nighttime driving. A 4-speed, electronically controlled transaxle offers selectable (normal or power) shift points. A trip computer, which Oldsmobile calls a driver information center, allows the driver to track his or her fuel economy, speed, engine oil pressure and life, battery life, transaxle fluid life, distance to destination, estimated time of arrival, and more. Remote-controlled door and trunk locks are also standard.

As a luxury car, the Aurora also offers such creature comforts as upper and lower lumbar supports for both the driver and the front-seat passenger, and dual temperature control so that both the driver and passenger can be comfortable. The driver's seat offers two position memories so that if two people regularly share the car, each can store a preferred seat position. Even more important, the outside rear-view mirror positions are also stored with the seat location in the memories. As an added convenience, pressing both memory buttons simultaneously causes the seat to move completely down and back for easier exiting.

The Aurora's power steering offers what Oldsmobile calls magnetic speed-variable assist. That feature keys the strength of the power-steering assist to road speed—maximum assist is provided during parking maneuvers, and minimum assist is provided at highway speeds so that the driver always has a comfortable feel of control. Best of all, the adjustment is continuously variable, so it is transparent to the driver; we were never consciously aware that the assist level was changing, even though it was obvious that it did.

In general, the Aurora is fantastic. It provides a quiet, comfortable ride while still providing a good feel for the road, and V-8 performance that we normally wouldn't associate with Oldsmobile. On the twisting roads of upstate New York, the car's performance made it a thrill to drive. On the other hand, its luxurious surroundings made the slow, rush-hour traffic of New York City bearable and maybe even enjoyable.

To be honest, however, we must plead ignorance when it comes to luxury cars—our real-world experience with them is, shall we say, limited. So we turned our attention to one of the three pieces of optional equipment that we do know something about. No it's not the V-rated Michelin tires or the engine block heater. It's the *Bose Acoustimass* audio system that we spent most of our time examining.

Oldsmobile selected Bose in an attempt to persuade Aurora customers to buy a factory-installed sound system instead of an aftermarket system. The auto-sound aftermarket is an extremely strong industry. A survey conducted by the Electronic Industries Association found that more than 70 percent of all U.S. households own at least one piece of aftermarket car-stereo equipment. Twenty-three percent of those surveyed intended to buy an aftermarket autosound product in the next 12 months.

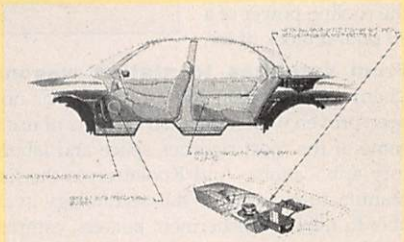
However, a factory system can provide a distinct advantage over aftermarket installation. Specifically, the sound system can be custom tailored to the vehicle. The system designer knows what the interior is like, where the speakers will be mounted, where the passengers will sit, and even how big the trunk is. Using that information allows him to design a complete system that, in theory, should out-perform a system assembled from stock components.

The Bose audio system installed in the Aurora consists of an AM/FM/cassette head unit, a 12-disc trunk-mounted CD changer, six speakers, and an Acoustimass enclosure.

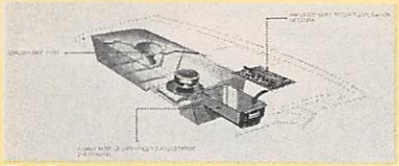
Bose's Acoustimass speaker technology is the same that is used in several of the company's home products, including its AM-5 and AM-3 speaker systems. The Acoustimass enclosure launches sound in the form of a mass of air, rather than directly from a vibrating surface like a speaker cone. A speaker cone is still used, of course—in this case a 6½-inch woofer—but it is the air that is sent forth from the enclosure's port, after passing through resonant cavities, that does the work.

The Acoustimass enclosure acts as an acoustic bandpass filter, and it also helps to limit the speaker cone's excursion, thus reducing distortion.

The Acoustimass enclosure delivers bass response that is surprisingly clean, smooth, and powerful despite the module's relatively modest size. In fact, the module is quite inconspicuous—it is integrated in to the rear package shelf. Even when you open the trunk you won't notice it unless you look for it.



The Bose Acoustimass system consists of six speakers plus the Acoustimass enclosure.



The Powered Acoustimass enclosure is an integral part of the Aurora's package shelf.

Mounted to the Acoustimass enclosure is the power-amplifier module, which contains one amplifier for the Acoustimass enclosure and four other amplifiers for the main speakers. Each amplifier includes active and dynamic equalization networks that work together to provide accurate sound and tonal balance at any listening level. For example, at low volume levels, the deep bass is automatically boosted.

The beauty of the Acoustimass enclosure is not that it is visibly inconspicuous. More important, the module—despite its impressive bass output—is *acoustically* inconspicuous. Whether we were in the front seat or back—even with our head directly in front of the Acoustimass port—we never localized on the bass. We could carry on conversations with front- or rear-seat passengers comfortably even while enjoying the music. No one felt as if they were being beaten over the head by an aggressive stereo system.

Six other speakers round out the Bose system. Each front door holds a 6½-inch Bose woofer, and each front kick panel houses a 1½-inch tweeter. In each rear door is a 3½-inch Bose "Twiddler" speaker. The speakers are mounted to create a cross-fire pattern that provides what Bose calls a "Stereo Everywhere" effect.

Bose certainly was effective with "Stereo Everywhere." Sounds seemed to emanate from every corner of the car! Unfortunately, that's not how we like our imaging—it isn't realistic. It was disconcerting to hear trumpets blaring from what seemed like the floor behind us. Yes, the system washed the car in sound, and we're sure that that is what Bose's engineers intended.

Except for our displeasure with the imaging, the system performed very much to our liking. The head unit was well designed and easy to use. All of the controls were obvious with one exception: The button for random CD-track playback was unlabeled. Controls mounted on the steering wheel for basic functions were easy to adapt to, but the placement of the head unit, curved slightly toward the driver, didn't require undue attention.

Although the Bose system performed admirably, it was not as much to our liking as other Bose auto implementations. An aftermarket system, we think, could probably do a better job—but whether it could match the $1000 price premium of the Bose system is uncertain. ■

GIZMO NEWS

Balance of Trade

The Electronic Industries Association reports that U.S. exports of electronic products reached more than $48 billion in the first half of 1994. That represents a growth rate of about 16% over the previous year. However, U.S. *imports* of electronics were up even more: 18%. The resulting negative balance of trade for electronics in the first half of 1994 was $7.9 billion.

When he announced the trade statistics, EIA President Peter F. McCloskey said, "U.S. exports are continuing to exhibit substantial vitality and improvement in global market share. This is particularly true of outstanding performing sectors such as telecommunications and solid-state products."

The category where the U.S. had the largest positive balance of trade, $2.5 billion, was in industrial electronics. The worst performance, as might be expected, was in consumer electronics, where the U.S. had a $6.4 billion negative balance. Other negative categories include computers and peripherals and passive components.

Meanwhile, the U.S. Semiconductor Industry Association reported that success "can be achieved by sustained efforts to improve foreign access to Japan's semiconductor market." The association reported that the foreign share of Japan's semiconductor market exceeded 20% for the first three quarters of 1994.

Speaking of the 1991 U.S.-Japan Semiconductor Trade Agreement, the association said, "The foreign share increase is a result of the sincere efforts being made by all parties to provide competitive products to Japanese customers, coupled with the movement offshore of low-end consumer electronics, which have a relatively small foreign market share. However, no one should be satisfied until the notion of a truly open Japanese semiconductor market becomes a reality."

In July, 1994, Japan made an effort to terminate the 1991 agreement. The association said that it hoped "that Japan's effort ... is not an indication of a lack of commitment to continue to improve market access. Instead, we are once again calling upon the Japanese industry to match our commitment to provide choice to Japanese consumers, and ensuring a truly open market for all semiconductor competitors."

Theft-Proof Radios

Car alarms have become mere noisemakers instead of theft deterrents. However, Eclipse (Torrance, CA) has so much confidence in the theft-deterrence provided with its new ESN (Eclipse Security Network)-equipped AM/FM/CD players that the company guarantees to provide free replacement of the unit if it is stolen up to a year after purchase.

The units, when stolen from the vehicle, become inoperative. Thus, according to the company, "ESN-equipped units simply will not have any fence value." Unlike similar theft-deterrence systems, users don't have to remember any secret codes. Instead, they just have to remember their "Key CD." When the Eclipse unit is originally installed, the customer selects a CD from his collection. The CD player is then programmed to recognize that CD as the key.

After ten attempts to reactivate the system using incorrect CDs, the unit's display prompts the user to contact Eclipse for free repair and shipping. Once the unit is delivered for the "free repair," technicians can read an electronic serial number to identify the unit's registered owner.

Info Highway?

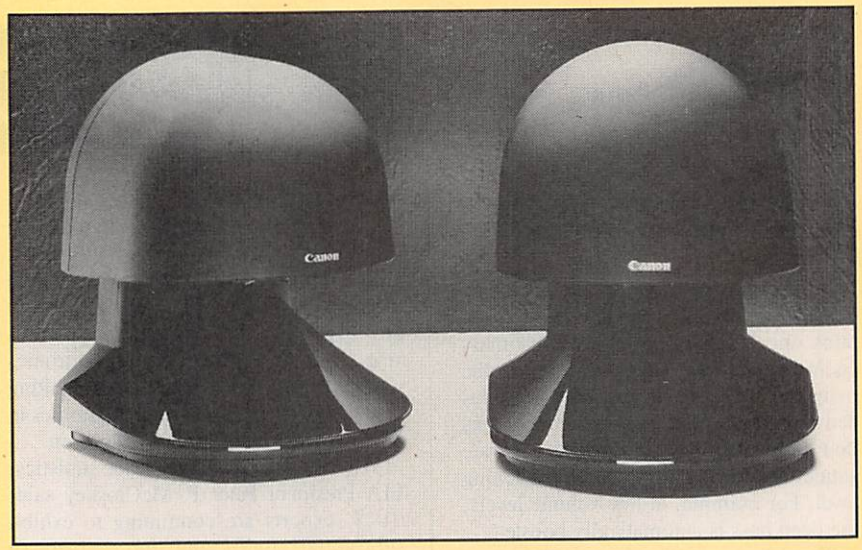
A survey conducted by the Times Mirror Center for The People and The Press found that 11-million U.S. homes are "already equipped to travel the information highway." Nearly one third of U.S. households own a personal computer, and about 23-million adults use a home computer every day. Twelve percent of all households have a modem-equipped computer, and as many as 6% of all Americans go online.

People who enjoy high-technology products are "voracious consumers of information," the study found. "They read more, follow the news more, and know more about the world than people who are not as technologically experienced." However, people who do access information using such high-tech methods as online services do not forsake such traditional information sources as newspapers and magazines.

The dominant home-technology device? Well, it's the TV, of course. Less than 60% of those surveyed, however, were satisfied with what's on, even though only 7% of all households used their TV for broadcast reception only. ■

Mushrooms of Music

S-35 LOUDSPEAKERS. Manufactured by: Canon U.S.A., Inc, One Canon Plaza, Lake Success, NY 11042. Price: about $425 per pair.



There have been many technological advances in audio over the last dozen years or so. But since the introduction of the CD player, it's not electronics that is advancing the most rapidly. Instead, it's the loudspeaker—the most mechanical component of an audio system—that continues to undergo the greatest refinement.

To a degree, the changes in speakers have been driven more by changes in fashion and lifestyle than because of new technological discoveries. But the continuing evolution in loudspeakers has come about for another reason as well. With the introduction of the compact disc and its uniformly good ability to accurately reproduce audio, the loudspeaker has unquestionably become the most important link—we should say the weakest link—in the audio-reproduction chain.

The bookshelf speaker—first introduced in the 1950's—is booming well into its middle age. There is one reason why bookshelf speakers are so popular: They allow flexibility in placement while still providing good performance, although they can't produce the deep bass response that only large, floor-standing speakers and subwoofers offer.

Canon U.S.A.'s S-35 loudspeakers—designed and built by Canon Audio in the U.K.—represent Canon's first entry in the U.S. audio market. They are also unlike any speaker system that has come into the *Gizmo* offices. First, they don't look as much like speakers as they look like oversized black mushrooms. A black matte-finished dome is suspended over a conical black plastic base. Nowhere is there a grille or grille cloth to be seen, or any other indication that these mushrooms are actually speakers, and not some funky modern sculpture.

In reality, the speaker drivers are mounted in the top dome. They don't fire into the room. Instead—in an unusual departure from standard speaker design—they fire downward. That is the secret to the wide image that the speakers are able to produce. You could say that it's done with mirrors. The conical black plastic base is not there just for aesthetic purposes, but is an acoustic mirror that reflects the drivers' outputs into the room.

The enclosure, which is built of plastic and internal zinc, has two rear-facing ports. The ports are located in the back of the top dome. However, the enclosure chamber includes both the top dome and the base.

The objective of the speakers' unique design is to provide a true stereo image up to six times larger than a conventional speaker so that more listeners, over a wider area, can enjoy stereo without crowding into the typical small "sweet spot" that is generated by conventional speakers. The Canon Wide Imaging Stereo technology is patented and it is, indeed, impressive.

The S-35 is a two-driver system. A 130 mm (5-inch) full-range driver provides the bass and midrange frequencies, while a 19-mm (¾-inch) dome tweeter is suspended in front of the bass driver and provides the treble frequencies. The rated frequency response is 70 Hz to 22 kHz, ±3 dB.

The S-35's tweeter is cooled with ferrofluid, which helps to give the speakers a power-handling rating of 75 watts maximum. The minimum power recommended is 10 watts, with 50 watts recommended as optimum. An overload protector, which integrates the speaker current over time (it gets hot, in other words), is provided to prevent damage to the speakers from misuse or amplifier malfunction. In an overload condition, attenuators will markedly reduce the volume of one or both speakers. The protection circuit automatically resets when the fault is corrected. However, the protection system has a "memory," and according to the manual, it will operate at progressively reduced levels if it suffers repeated overload.

The speakers' sensitivity is rated at 88 dB (for 2.83 volts at 1 meter), and their nominal impedance is six ohms. Their total harmonic distortion (THD), measured between 120 Hz to 12 kHz, is rated at less than 0.3%.

The S-35 loudspeakers are designed for a variety of applications, and they have a variety of mounting options. Dedicated stands or wall brackets are one option; direct-coupled attachment points are provided on the rear panel to maintain the rigidity of the structure. They can also be placed on top of a shelf or other furniture; six anti-slip stick-on feet are supplied for that purpose. Although not an optimum position, the speakers can even be placed on the floor.

Like all speakers, the frequency response of the S-35's depends greatly on their placement. The S-35's, perhaps because of their rear-facing ports, seem even more sensitive than most. For optimum imaging, Canon recommends positioning the speakers six to ten feet apart and tilted inward toward the listening area at an angle between 30 and 45 degrees.

We auditioned the speakers in an assortment of locations with an assortment of program material. In general, they performed quite well. They did suffer from the lack of deep bass that is inherent in small speakers, but when they were placed near room boundaries, the bass was firm and the speakers' response was balanced and even well into the treble range. The sound was neither boomy nor boxy.

What was truly impressive about the speakers, however, was their wide imaging. When positioned properly, the acoustic mirrors truly did spread the stereo image so that it was not confined to a small "hot spot" at a location that would be at the apex of a triangle (with the speakers at the two other corners). Instead, we were able to walk across the room without being aware of the speakers' placement, yet the stereo performance was superb throughout an angle of better than 90 degrees.

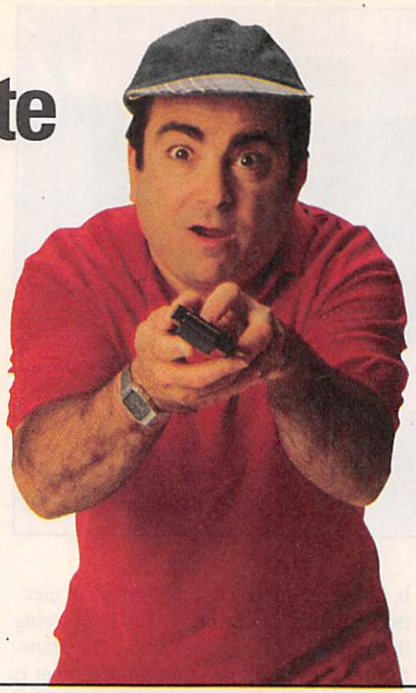
The imaging performance truly showed itself when we pressed the speakers into service as part of our video system. The S-35's are well suited to act as video speakers because they are magnetically shielded. They can be placed directly next to a video monitor without causing any distortion. ■

TECHNOLOGY UPDATE

Put the remote back into your remote control!

Amazing new device attaches to your existing remote control giving it the power to transmit anywhere, even through walls!

By Charles Anton



It's Thursday evening and you have dinner guests. The kids are watching TV but it's too loud. Without embarrassing yourself or the kids by yelling to turn it down, you pick up your remote with Leapfrog long range power and turn it down without a hassle.

Until now remote control has never been very "remote." Even with the best equipment you had to be right in front of your stereo, TV, VCR, etc. to make it work. Now you can operate your entire entertainment system from anywhere in your home with Leapfrog, the next generation in remote systems.

How "remote" is it? Imagine yourself at home enjoying a relaxing evening of movies on your VCR. You decide to stop the movie so you can get yourself a snack. You aim the remote and click, but nothing happens! You grow more and more irritated, and finally have to stand right in front of the VCR before you can get it to stop the movie. You find yourself wondering why they call it a "remote" in the first place.

Why all the hassle? Typical remotes use infrared technology. In order for the process to work, the remote must be in direct line-of-sight with the audio-visual equipment. The equipment must "see" the signal.

Radio revolution. The Leapfrog transmitter never needs to be perfectly "lined-up" with the TV, etc. Why? Because the transmitter doesn't rely on an infrared signal. You can even point it in the wrong direction and it still works. Leapfrog overcomes all the headaches of obsolete remote controls through the use of radio waves.

Radio waves work anywhere within a 150 foot range. The signals pass through walls, doors, ceilings and floors, letting you control your equipment from any room of your home. You cannot aim and miss.

Infrared to radio. The Leapfrog transmitter, which attaches to your existing remote control, sends radio signals to the Leapfrog receiver. This receiver then transmits the signal to your audio-visual equipment with infrared technology.

Versatile uses. This amazing new remote control modifier works with any infrared remote. Just imagine the convenience of controlling your VCR, TV, stereo, cable converter box, speakers in multiple rooms, or any other audio-visual system throughout your home.

Leapfrog is also ideal for use with universal remotes. Control it all with just one remote.

How does Leapfrog work?

Leapfrog converts your infrared remote signal to radio frequency. Radio frequencies enable the signals to pass through walls and other obstacles. It also allows signals to transmit up to 150 feet without staying in line-of-sight with your equipment. Leapfrog then re-transmits the signal to the receiver, which forwards it to your audio-visual equipment.

Leapfrog installs in minutes. The transmitter attaches to your current remote. Plug the receiver into any outlet and place it in line with your audio-visual equipment.

Leapfrog sends radio signals which pass through any non-metal obstacle, giving you complete control of your personal electronics system.

Talented remote. The Leapfrog is not another hand-held remote control. This powerful innovation actually modifies your current remote, thus enhancing its value. You can control your stereo, your VCR, your TV, etc. from anywhere. From across the room or from across the house.

You can even use Leapfrog from outside. This is a fantastic feature to have when you're out by the pool, on your patio, or in your garage.

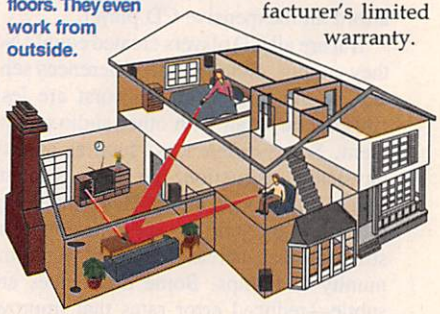
Factory direct. You would expect an innovative device like this to cost several hundred dollars. That might be the case if we sold only through exclusive high-end audio-visual dealers. But we bring the good news straight to you. You save money with factory direct prices.

Why Leapfrog beats infrared

- **Range.** You can control electronics from up to 150 feet away.
- **Aim.** You can't miss. Point your remote in the wrong direction and it'll still work.
- **Value.** It lets you get the most out of your audio-visual equipment by making use of it throughout your home.
- **Flexibility.** Because it sends signals through barriers, it lets you store your equipment behind cabinet doors.

Try it risk free. We are so confident that you will love Leapfrog that we've backed it up with our "No Questions Asked" 30 day money-back guarantee. If you are not completely satisfied for any reason, just return it for a full refund. Plus, it comes with a full one year manufacturer's limited warranty.

Leapfrog transmits signals in a range of up to 150 feet. Signals actually pass through walls, ceilings and floors. They even work from outside.



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COMTRAD INDUSTRIES

2820 Waterford Lake Drive Suite 106
Midlothian, Virginia 23113

High-End CD for the Masses

DX-1 COMPACT DISC PLAYER. Manufactured by: California Audio Labs, 16812 Gothard St., Huntington Beach, CA 92647. Tel: 714-841-1140. Price: $595.

Choosing a CD player can be one of the most difficult decisions you'll have to make about your audio system. CD players have, in a sense, become the great democratizer of hi-fi audio reproduction. The reproduction quality that was once available only to enthusiasts who could afford to lay out many hundreds, or even thousands, of dollars is now available to anyone who can afford an inexpensive CD player.

But are all CD players created equal? No they are not, although the differences separating the best from the worst are less conspicuous than with other audio equipment. Some differences, such as quality physical construction, are easily evident. Some differences are hidden, including the attention paid to the interior construction that increases a CD player's immunity to bumps. Some differences are subtle—reduced error rates that improve the accuracy of reproduction, for instance.

When we first unpacked the *California Audio Labs DX-1* single-disc CD player, we noticed that it had a look and feel that indicates quality. Housed in an attractive, black metal cabinet with a plastic front panel, the DX-1 has a balanced look. The CD drawer is at the center of the upper front panel, above the unit's display. Six pushbuttons are arranged in elegant symmetry, with three on each side of the display. The power button is at the upper left.

Some signs of the unit's quality aren't seen by the end user. For example, the AC line (which enters via an IEC power cable) is filtered to reduce the possibility of electromagnetic interference (EMI) entering the unit from the power line. The transformer is encased in a potting resin that is designed to reduce the emission of EMI interference that can affect low-level signals. An internal steel subchassis isolates the transport mechanism from external vibration to reduce potential read errors. Even the disc clamp is specially designed to support one third of the CD's surface.

The lenses in the DX-1's optical system are glass, rather than the usual plastic. They are mounted in a diecast housing to improve heat dissipation, and the assembly is transported by a linear worm-drive. The tracking, focusing, and rotational speed servos are digital instead of analog, which, according to California Audio Labs, provides a tenfold improvement in servo speed and accuracy. Thanks to the improved servo accuracy, the DX-1 is said to reduce the amount of error correction that is usually required to compensate for lost bits.

The digital-to-analog converter (DAC) in the DX-1, custom designed for California Audio Labs by Matsushita, is a delta-sigma (1-bit) design with 16-bit resolution. (One-bit converters can provide reduced quantization errors as compared with multi-bit converters, yet they don't require expensive calibration and trimming.)

According to a company spokesman, the DAC design was chosen to allow the high-frequency signal to be equalized in the analog stage. The intent of the equalization is to simulate the frequency response of a moving-coil phono cartridge,and thus give the DX-1 an analog-like sound. We're not sure how to reconcile that intent with the DX-1's virtually flat frequency response.

Unlike most CD players, the DX-1 has the DAC circuitry mounted to the transport mechanism. The rationale for that is to reduce the length of the digital transmission path to eliminate the introduction of clock jitter. Because of that, the analog signal path, which we would normally consider to be more prone to the effects of interference, is longer. Perhaps the longer signal path is not an important factor because the DX-1 "avoids the use of performance-limiting integrated circuits, using only premium-grade, discrete components in its analog section."

Operating the DX-1 is straightforward. The three buttons to the left of the display are to open the disc tray, and to play and pause the disc. To the right of the display are buttons to select the next or previous track, and a welcome but somewhat unusual stop function. The stop mode allows you to keep the DX-1's power on continuously without running the spindle motor needlessly. The display shows the track number, the track time (elapsed or remaining) or disc time (remaining), and a 15-track "music calendar."

The display can be read easily from directly in front, but beomes indistinct at an angle. Unless you mount the CD player at eye level, expect to do some neck craning to see the display. If you prefer not to be distracted by the glowing display, you can turn off the backlight with a push of the LIGHT BUTTON on the remote control.

The remote control provides access to a number of other functions as well, including two-speed audible search (backward and forward), and random track play. The display's time mode can be changed only from the remote, and tracks can be accessed directly from the numeric keypad.

The remote also allows the DX-1 to be programmed. Up to 20 tracks can be programmed to play in a chosen or random order. Finally, the remote allows access to a music scan mode in which the first 15 seconds of each track on the disc is played.

The rear panel of the DX-1 offers an IEC power connector, standard phono jacks for left- and right-channel outputs, and a digital audio output. The digital output supports connection via a 75-ohm coaxial cable; an optical output is not provided.

Does all the extra care taken by California Audio Labs show up when listening to the DX-1? Although we listened in a wide variety of situations, with different amplifiers and speakers, we auditioned the DX-1 mainly in one comfortable listening room. The music we listened to was varied, ranging from a Glen Gould recording of Bach's Goldberg Variations to recent recording of jazz saxophonist Henry Threadgill, and everything in between.

The DX-1 seemed to disappear from the audio-reproduction chain in a way that many CD players don't. All that was left was its very musical performance. We weren't listening to a CD player, we were listening to the music. What more can you ask from a CD player? ■

ELECTRONICS WISH LIST

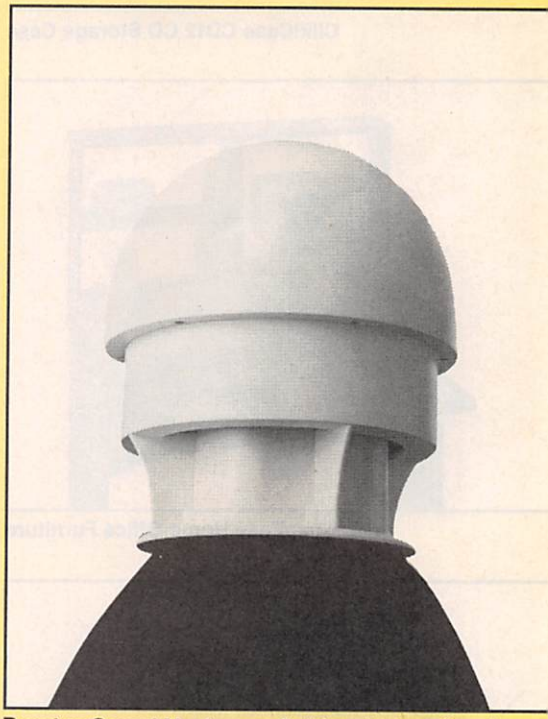
Traveling Scale

How do you keep track of your weight when you need to most—when you're on the road, eating in restaurants three times a day? Pack the *MiniScale* from *Norix International, Ltd.* (575 Grove Street, #C9, Clifton, NJ 07013). Weighing just 13 ounces, and measuring a compact 4½ inches in diameter, the MiniScale fits easily into any suitcase, briefcase, or gym bag. When you place the ball of one foot on the scale (while supporting yourself lightly with both hands on the wall) and lean forward, the microprocessor-based device precisely determines your weight in one second. By pressing the mode button, the weight display is replaced by a time display—the MiniScale does double-duty as a travel alarm clock. Price: $69.95.

Digital Travel Scale/Alarm Clock

Outdoor/Indoor Speaker

Intended for both indoor and outdoor applications, the *Sound Mushroom Model 410* from *Recoton* (46-23 Crane Street, Long Island City, NY 11101) is a portable 900-MHz wireless amplified speaker that takes its name from its distinctive domed enclosure. Powered by a rechargeable sealed lead-acid battery that lasts for more than 10 hours on a single charge, the speaker can be used far from the nearest electrical outlet. Its high-impact copolymer enclosure sheds rain, is indifferent to heat or cold, and resists both cracking and discoloration. The Sound Mushroom has its own on/off switch, volume control, and a tuning control that locks precisely on the 900-MHz-range frequency used by the included transmitter to send signals to the speaker. When the signal is locked in, an LED indicator glows to confirm it. Price: $199.99.



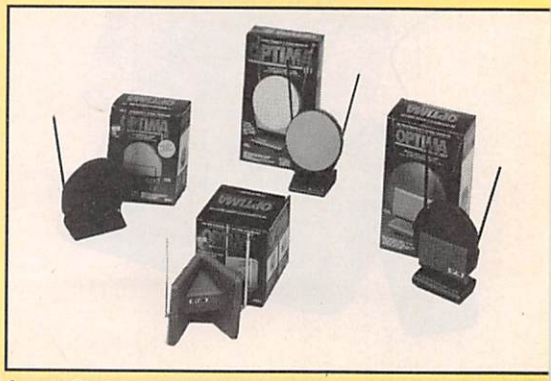
Recoton Sound Mushroom Outdoor/Indoor Speaker

Home-Theater TV

The 35-inch *RCA 3571MB* from *Thomson Consumer Electronics* (10330 North Meridian Street, Indianapolis, IN 46290-1024) couples big-screen action and the SRS Sound Retrieval System with convenience features designed to enhance viewer enjoyment. The SRS system "fills the room with sound without the aid of external speakers, wires, or other equipment." The set features Thomson's optimum-contrast dark-glass picture tube and 110-degree very high performance (VHP) system. Those two technologies combine to provide outstanding picture contrast even in brightly lit rooms. Convenience features include color-coded monitor panels for easy connection of video and audio components; advanced color picture-in-picture, which allows the viewer to adjust the inset picture size and position; and channel guide, for previewing up to 12 channels at the same time. A remote-controlled on-screen menu system visually guides consumers through TV features and operations. Price: $2199.

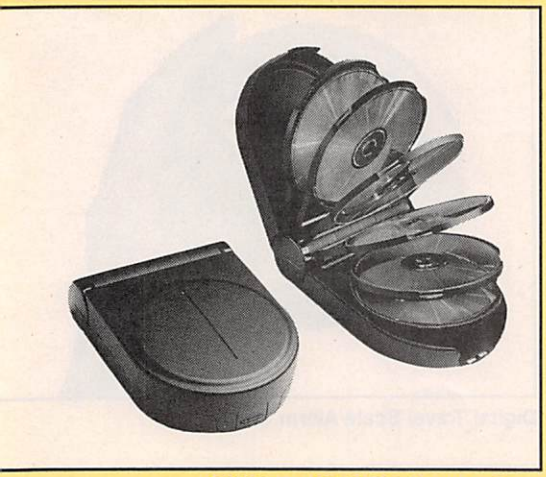
Television Antennas

The four new television antennas in *Jasco Products'* (311 N.W. 122nd, Oklahoma City, OK 73114) *Optima* line are said to feature the same advanced microwave technology used in military radar systems. As Jasco explains it, conventional indoor antennas receive only the horizontal component of incoming electromagnetic waves, while Optima antennas use a circularly polarized element to receive the vertical component as well. Supposedly, that results in up to twice the signal reception, with no need to aim the antenna at the incoming signal. The line includes the amplified *Model 8229*, which is equipped with a built-in "OptiAmp," a tilt/swivel hinge, and black dipoles. The antenna features a stabilizing base weight and four suction-cup base supports for secure placement on any flat surface. Prices: $24.99 to $89.99.



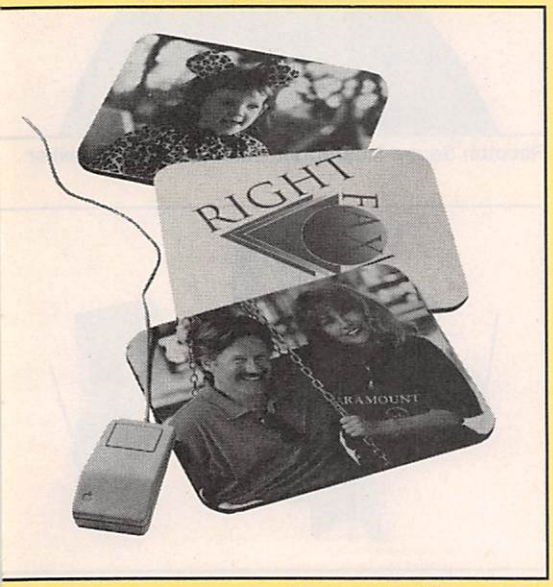
Jasco Optima Antennas

ELECTRONICS WISH LIST



Clik!Case CD12 CD Storage Case

SnapEase Home-Office Furniture



Personalized Mouse Pads

Clik!Case CD Holder

Recently awarded a Bronze prize in the 1994 Industrial Designers Society of America Industrial Design Awards Competition, the *Clik!Case CD 12* carrier provides maximum protection for 12 CD's without their jewelbox cases. The Clik!Case has a molded plastic outer shell that is "virtually indestructible," according to *Outer Circle Products, Ltd.* (860 West Evergreen Avenue, Chicago, IL 60622). Six individually hinged trays hold two discs each and flip up or down for easy disc selection. The trays lock to hold the CD's firmly in place. A center grip raises the discs above the tray surface for easy pop-up release. Price: less than $10.

Rubbermaid Office Furniture

When you think of *Rubbermaid* office products, what probably comes immediately to mind is the traditional "round file cabinet" in which you toss trash. Think again. Rubbermaid now furnishes complete offices, with its line of *SnapEase* ready-to-assemble furniture. The line, marketed by a division of Rubbermaid called *MicroComputer Accessories, Inc.* (9920 La Cienega Blvd., Inglewood, CA 90308-7032), includes a 46-inch computer desk, a matching hutch, and a printer cart. Aimed at home and small offices, the furniture features contemporary design, scratch-resistant materials, and simple assembly. SnapEase products assemble with a snap-lock mechanism that requires no tools. The desk, *Model 7300*, can hold a computer, monitor, and printer. It has a full-width, glide-out keyboard drawer that includes a storage area for diskettes. The desktop inlay is reversible; one side is solid gray, the other has a maple woodgrain pattern. The hutch, *Model 7305*, frees up desk space by providing extra storage for manuals and supplies, and features a movable shelf. The *Model 7105* printer cart has two rear wheels and nests beneath the desk when not in use. Prices: desk: $299; hutch: $89.95; printer cart: $59.95.

Video-GameSaver

Don't you hate it when you're "killed" while playing a high level of a video game, and then have to play through all the lower levels again to get back to that point? The *GameSaver* from *Naki International* (Century City North, 10100 Santa Monica Blvd., Suite 1400, Los Angeles, CA 90067) is a patented, plug-in cartridge that allows Sega or Super Nintendo players to pinpoint, save, and return to exact moments in a game to conquer new levels faster and eliminate frustrating, repetitive game play. For example, if a player conquers the first three levels of a game and keeps losing at the same obstacle in level four, he simply pushes the GameSaver button to mark and return to that spot. Even if the system is accidentally unplugged, the cartridge will save the instructions. GameSaver plugs into the video game cartridge slot and then any game can be inserted into the GameSaver cartridge slot. The GameSaver unit can even be transferred to another Sega or SNES system without losing the data. The point saved is remembered for up to 30 hours using four "AA" batteries or a Game Boy-compatible rechargeable battery pack. Price: $49.99.

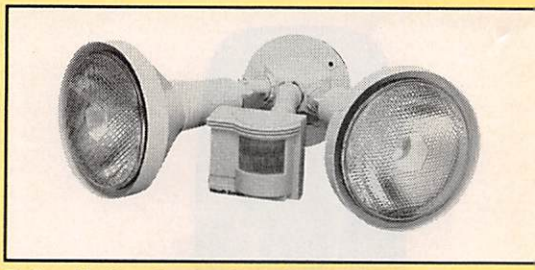
Personalized Mouse Pads

You can get your favorite pictures out of your wallet and onto your desk with a *Personalized Mouse Pad*. Send your photograph, drawing, or computer art to *V.I.P. Communications* (P. O. Box 35790, Tucson, AZ 85740), and they will professionally reproduce your image on a mouse pad using state-of-the-art laser printing technology. Computer artwork can be reproduced directly from postscript files. You can also advertise your business by putting the company's logo on mouse pads that are distributed to new or existing clients. All original photos, art, or disks will be returned with the order. Price: $19.95 each in small quantities; large orders are discounted.

ELECTRONICS WISH LIST

Motion Sensor Security Light

Bell-shaped lamp holders add a distinctive look and increased lamp protection to the *Reflex Designer Motion Security Light Model SL-5315* from *Heath Zenith* (455 Riverview Drive, P. O. Box 1288, Benton Harbor, MI 49022). The fixture senses heat in motion, and produces a sudden shower of light to startle intruders or unwelcome guests. A selectable dusk timer turns lights on for up to four hours after dusk. Users can also turn the lights on at night from a standard wall switch. At daylight, the sensor resets the unit to the automatic motion-sensing mode. Another safety feature is the selectable security flasher, which sets the lights flashing when motion is detected in the sensor's field. The user can choose the amount of time (from one to 20 minutes) before the unit automatically stops flashing. The security light controls two 150-watt floodlights and detects motion as far as 70 feet away. Three overlapping detection zones provide an effective coverage area of up to 4000 square feet. Price: $35.



Reflex Motion-Sensor Security Light

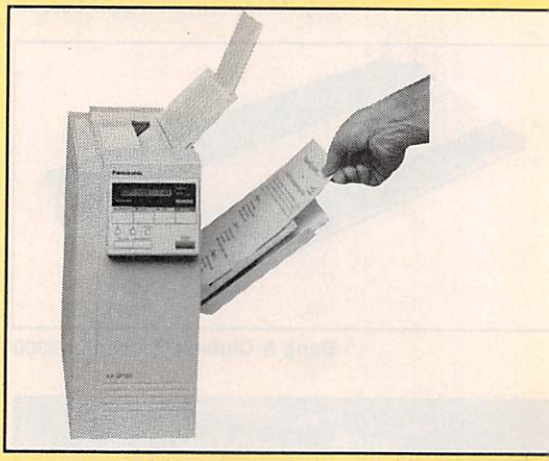
Cordless Digital Answering System

The *Cordless Digital Answering System 5650* from *AT&T* (Consumer Products Division, 5 Wood Hollow Road, 3L11, Parsippany, NJ 07054) combines a cord less telephone and a digital answering system in one unit. Users can retrieve messages remotely from either the cordless handset or any touch tone phone. The answering system records incoming messages and an outgoing announcement on a memory chip with 26 minutes of recording time. The 10-channel cordless telephone features a speakerphone with dial in the base, two-way page and intercom, and nine-number memory. Price: $259.

AT&F Digital Answering System/Cordless Phone

Plain-Paper Printer/Fax/Copier

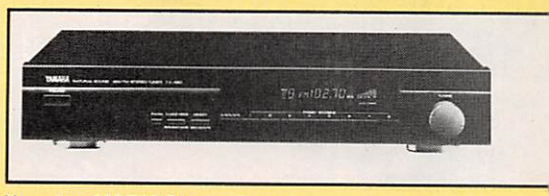
Home offices are notoriously short on space, so multifunction devices are particularly appealing. The *PFC Model KX-SP100* from *Panasonic Communications & Systems Company* (Two Panasonic Way, Secaucus, NJ 07094) fits the bill, serving as a plain-paper printer, Fax, and copier in one compact unit. With its unique, upright design, the PFC can fit on a desk beside a computer and doesn't require additional office furniture. The unit's telephone/Fax switch eliminates the need for a dedicated phone line for the Fax. The Energy Star-compliant PFC saves on electricity by cutting down the number of office machines drawing power. And having the copier, Fax, and printer right on the desk allows workers greater privacy and control over their documents. The printer is a full-featured, laser-quality (300-dpi) personal page printer with a 70-page input tray that holds either letter- or legal-sized paper. The plain-paper Fax features a 10-page automatic document feeder, auto-reduction mode, and a journal-print function that lists the last 35 transmissions and/or receptions. It connects to a desktop phone and such Fax functions as speed dial and redial are accessed directly from the phone's handset. The PFC will accept an incoming Fax while the printer is in operation and store up to 18 pages (or up to 104 pages with optional RAM expansion boards) in memory for later retrieval. As a copier, the PFC features a 10-page automatic document feed; medium, light, and dark settings; and fine and halftone modes. Price: $999.



Panasonic PFC Plain-Paper Printer/Fax/Copier

Entry-Level AM/FM Stereo Tuner

The *TX-480* is the first entry-level AM/FM tuner from *Yamaha Electronics Corporation, USA* (6660 Orangethorpe Avenue, Buena Park, CA 90620) to feature rotary electronic tuning. Other convenience features include preset exchange, which allows a user to easily change or reassign any or all of the 40 preset stations, and a three-way, multi-status station name display. Incorporating Yamaha's "Alpha" (Absolute Linear Phase IF) circuitry, the TX-480 offers improved selectivity without sacrificing linearity. High adjacent-station rejection is important in urban areas where stations might impinge on each other's prescribed frequency. A wireless remote control is available optionally. Price: $199.



Yamaha AM/FM Stereo Tuner

ELECTRONICS WISH LIST

Pioneer Bodysonic Speaker

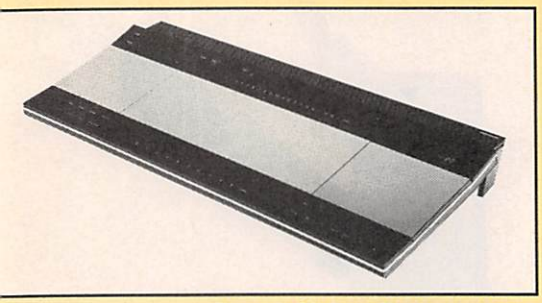
"Bodysonic" Car-Audio Speaker

Pioneer Electronics' (2265 East 220th Street, Long Beach, CA 90810-1639) *BSS-C1 Bodysonic Speaker System* allows consumers to "feel" the music playback of their car-audio systems. The speaker, which is designed primarily to improve bass sound reproduction and listening enjoyment in the noisy environments found in convertibles, hatchbacks, and sport utility vehicles, fits onto the backs of driver and passenger seats. The system consists of a small, easily installed amplifier unit, a remote control, and the seat-fitting speaker pad. Price: $300.

Sony Handycam with LCD Screen

Camcorder with Built-In Color Monitor

Sony's (1 Sony Drive, Park Ridge, NJ 07656) *CCD-FX730V Handycam* 8mm camcorder allows users the choice of framing their shots on a three-inch color LCD screen or by using the camcorder's traditional viewfinder. Video footage can be played back immediately using the built-in LCD screen and speaker, or by connecting the camcorder to a TV to view the video on a larger screen. The LCD monitor is mounted on the side of the camcorder, where it can be folded out when needed. The screen can be tilted and turned, allowing users to capture shots from difficult or unusual angles. When not in use, the LCD folds flush against the side of the camcorder. The CCD-FX730V also features an optical 12:1 variable-speed power zoom; four-mode program auto-exposure control; age insert, an electronic calendar that can automatically update and superimpose age information for up to three children; quick record, to begin recording in one-fifth of a second; an audio/video digital fader; and AFM hi-fi sound. Price: $1099.



Bang & Olufsen Beocenter 9300

Multi-Room Music Center

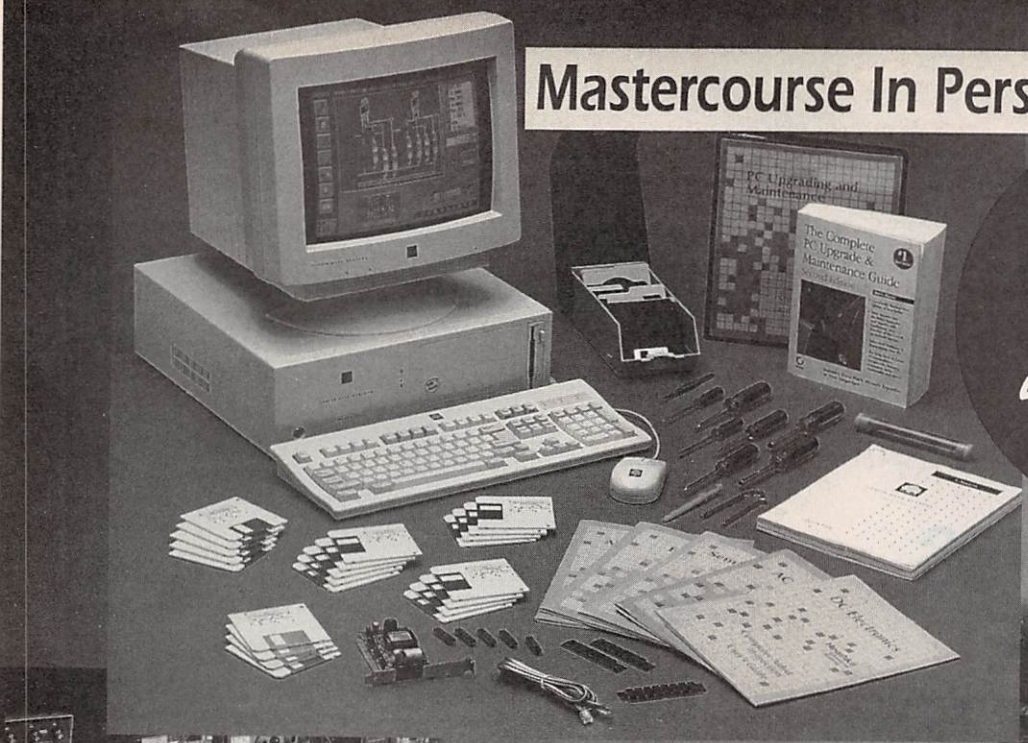
The *Beocenter 9300* from *Bang & Olufsen of America, Inc.* (1200 Business Center Drive, #100, Mt. Prospect, IL 60056) is a remote-controlled, compact music center that offers multi-room communication. It contains an FM/AM radio, a stereo amplifier, an auto-reverse cassette recorder, and a compact-disc player in a single, elegant cabinet. The slender, tapered cabinet, which is surfaced in highly polished aluminum and black glass, features "sensi-touch" glass panels instead of conventional buttons or knobs. Proprietary operational menus controlled by a microcomputer work as a "guided tour" of all functions including timer programming—with 15 events for timed play and recording of all internal sources—for one-time or multiple programs for different times and days of the week. Two pairs of passive Beovox loudspeakers or up to ten pairs of Beolab powered speakers can be connected to the Beocenter 9300 for home-theater or multi-room use. Line-in and -out connectors allow the addition of accessory equipment such as surround sound processors. Price: $2995.

Sigma Designs ReelMagic

MPEG Multimedia Plug-in Board

ReelMagic from *Sigma Designs* (46501 Landing Parkway, Fremont, CA 94538) is the first consumer-priced MPEG playback card for the PC. Based on the MPEG standard for compression, ReelMagic decompresses video and audio in real time, allowing up to 74 minutes of full-screen, full-motion video and CD-quality audio sound to be played from a standard CD-ROM drive. More than 50 ReelMagic-compatible titles will be ready by Christmas. Scheduled for shipping this past summer were 20 new titles, including *Space Ace* from ReadySoft, *Return to Zork* from Activision, *Lord of the Rings* from Interplay Productions, *World Cup Soccer* from CD-Vision, *Sporting News Football* from Compton's NewMedia, and *World Atlas* and *20th Century Video Almanac* from The Software Toolworks. ReelMagic can also play Video CD movies on 5-inch discs. Price: $449 with 16-bit DSP sound controller.

Mastercourse In Personal Computers



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CIRCLE 155 ON FREE INFORMATION CARD

A Hands-on Electronics® REPORT

ELENCO ELECTRONICS TELEPHONE LINE ANALYZER

CIRCLE 119 ON FREE INFORMATION CARD

Buy it or build it, because you'll need one in this information age.

While the telecommunications revolution started way back when the telegraph was hot, it is far from over. The fact that Fax's and modems are migrating from the work place to the home is evidence that the battle field is only getting larger.

If your home, office, or home-office communications hardware is growing as a result (an answering machine here, a Fax there), you are likely to encounter an installation problem sooner or later. For example, you might load the phone line with too many devices. It's also possible that one of your phone-line jacks has its polarity wrong and will cause trouble with a newly purchased device.

Of course the phone company will gladly service your needs, but you must pay an extra monthly fee, every month, whether you place a service call or not. Alternatively, you can maintain your internal phone lines yourself. For that you'll need two things: some idea of how a phone works, and a phone-line analyzer.

You get both of the above with the *Elenco Model 400K Telephone Line Analyzer* kit, available for $21.50 from Elenco Electronics (150 West Carpenter Ave., Wheeling, IL 60090-6062; Tel. 708-541-3800). It comes with a thorough tutorial on phone technology, and everything you need to build an analyzer. For those who would just like to use the analyzer without having to build it or understand its workings, it is available pre-assembled, without a tutorial, for $33.25 as the Model 400.

Regardless of which model you choose, the analyzer is novice-friendly. For all but one of the tests it performs, you simply plug a phone into the analyzer's front-panel jack, and plug the analyzer (which comes with its own cord) into a phone-line jack. It only has one control: a two-position switch that you set according to which test you're performing. The test indicators are a simplified meter (which has colored "regions" instead of a numbered scale) and an LED used to indicate polarity.

Use. To give you an idea of the analyzer's usefulness, let's discuss the tests it performs. First, there is a "line test" that detects overloading from a defective phone or shorted wiring. During that test, an overload is indicated by a low reading on the meter. Also, if the unit's polarity LED lights up, it means the phone-line wires are reversed, which can cause problems for some equipment.

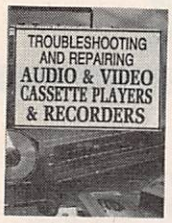
Second, a "ring test" determines whether a phone's ringer, the phone line, or line loading is to blame for a lack of audible ringing. To do that, the meter is used to rate the quality of the incoming ring signal. That test is very useful, as it is easy to misconstrue missed calls as a telephone-company problem, when in fact you've just got too many telecom goodies on the line.

Third, a "loop test" helps you find out if the problem is in your internal wiring or in the outdoor phone line. That is obviously a *must* for determining the responsible party.

Last, a "telephone-cord test" allows you to check phone cords for loose connectors and such. For that, the suspect cord is left connected to the wall jack of the phone line, and the other end is plugged into the analyzer's front-panel. Next, the cord of the analyzer is plugged into the phone. If the meter reading varies while the suspicious phone cord is jiggled, the cord is bad.

To expedite the tests, the documentation contains both simplified and detailed instructions. The simplified in-

(Continued on page 89)



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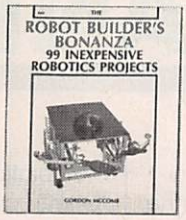

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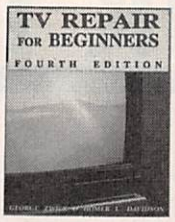

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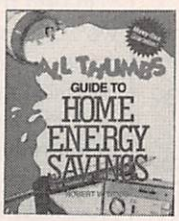

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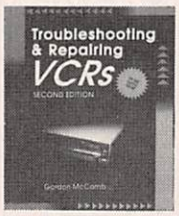

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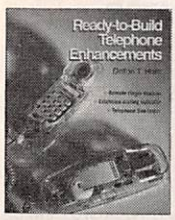

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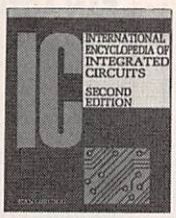

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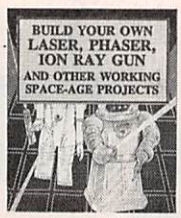

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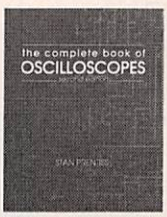

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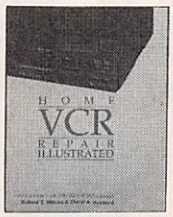

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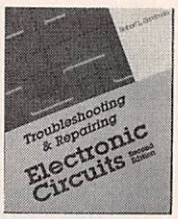

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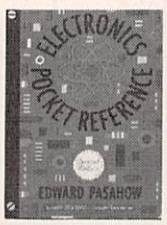

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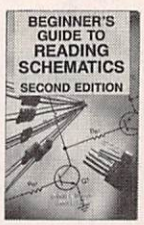

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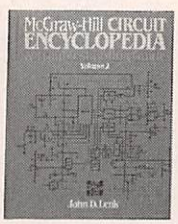

0376107-XX $59.50
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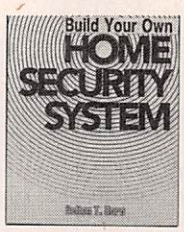

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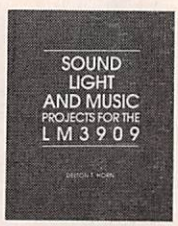

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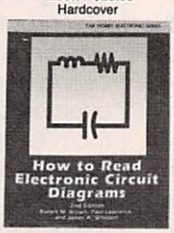

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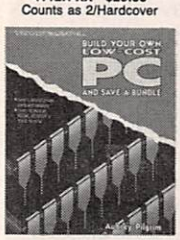

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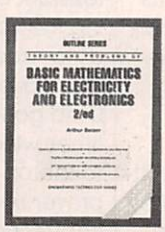

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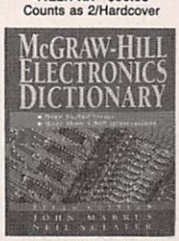

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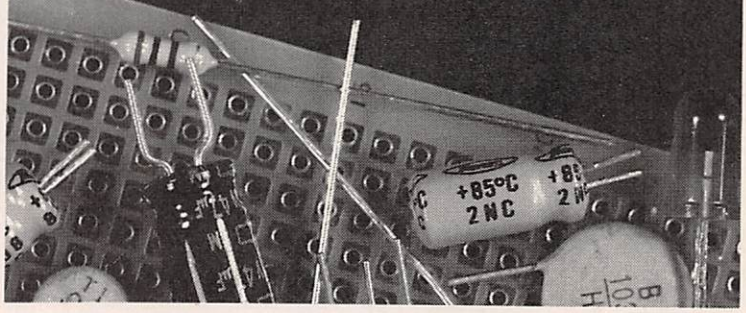

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THINK TANK

By John J. Yacono
Technical Editor,
Windows Magazine

Temperature-Controlled Circuits

Over the last three months, I covered enough ground to explain the concepts of current and voltage (or potential), as well as other electrical phenomena. As promised, this month I'll explain resistance and its relationship to current and voltage. To please the more savvy readers, I'll also present letters containing some temperature-sensing circuits.

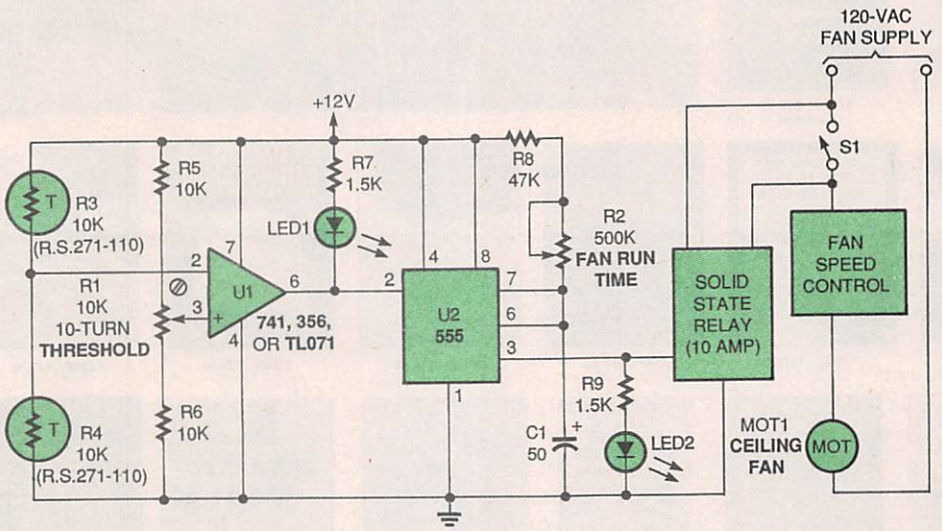

Fig. 1. This circuit measures temperature differences, not temperature. Once the difference passes a certain threshold, the timer is triggered, activating the solid-state relay.

Let me start by re-introducing last month's "water-in-a-pipe analogy." In that analogy, water represents electrons, the flow of water is current, a series of pipes are like a wire, a water pump is a battery, and the difference in pressure between the pump's inlet and outlet is the battery's voltage.

Let's say the pump's inlet and outlet are connected to the ends of a series of pipes. If the pipes and pump are full of water, turning on the pump (battery) causes the water (electrons) to flow (like current) from the outlet of the pump (the negative battery terminal), through the pipes (wires), and back to the pump's inlet (the positive battery terminal).

Now let's upset that harmonious picture by placing a valve somewhere along the pipe network. If we partially close the valve, the current decreases and the pressure difference between the pump's inlet and outlet increases. In fact, the change in pressure is proportional to the change in water current. The action of the valve on water current (or electron current) and pressure (*i.e.*, voltage) is so precise, we can give it a name. In fluid dynamics it's called "pressure head," but in electronics it's called "resistance."

Of course, the relationship between resistance, current, and voltage didn't go unnoticed by early scientists, and led to the famous equation:

$$R = E/I$$

That relationship is called "Ohm's Law," and resistance is measured in units called "ohms." Both are named in honor of a pioneering scientist. That law is perhaps the most fundamental rule in all of electronics. All hobbyists commit that rule to memory as a matter of course.

In next month's column we'll discuss our first component: the "resistor." I'll describe its effect on current flow, and some of the different types of resistors you're likely to encounter. Now, its letter time.

FAN ACTUATOR

In a building with high ceilings, which is heated with a wood-burning stove, a ceiling fan was installed to circulate the heat. But the fan had to be manually switched on when the stove was lit. Since I'm a bit lazy at times, I built this circuit (see Fig. 1) to automate the fan.

The op-amp, U1, is placed in a comparator configuration with two thermistors—one located at the ceiling, one at the floor. The IC senses the temperature difference between the ceiling and floor, but is unaffected by the overall room temperature. When the temperature differential increases, the upper thermistor will decrease in resistance, eventually causing the voltage at pin 2 of U1 to exceed that at pin 3. That causes the output of U1 to go low and trip the timer, which adds hysteresis to the op-amp's output, preventing the motor from chattering. When tripped, the timer activates the relay, which activates the fan.

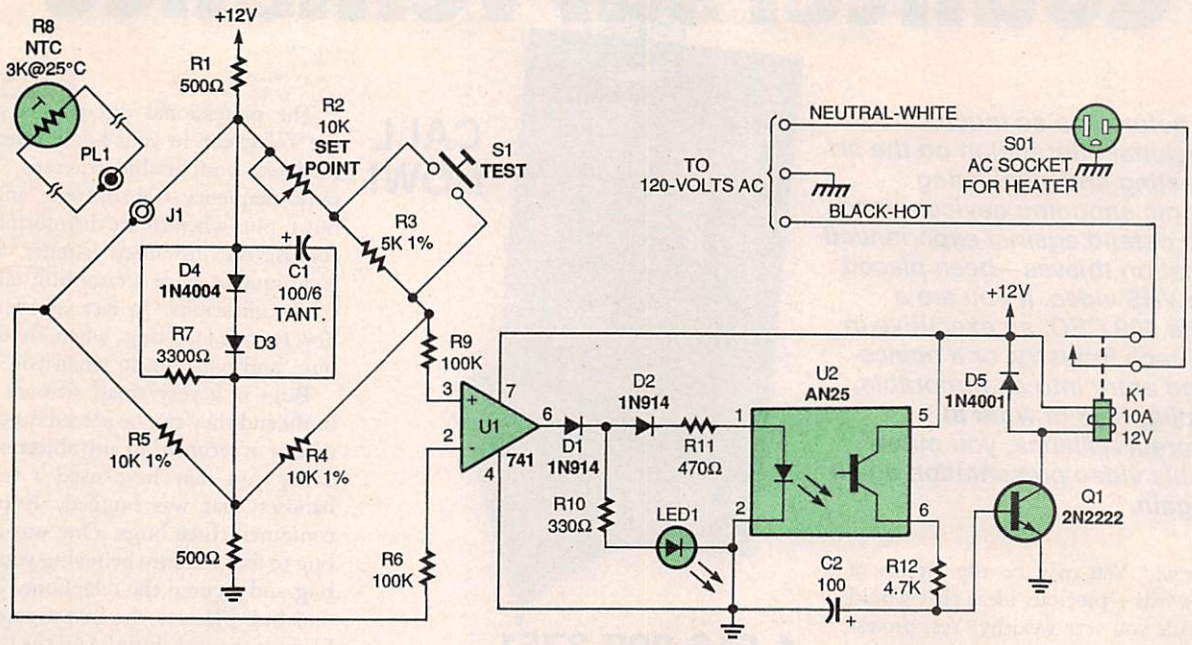

Fig. 2. Using a bridge circuit to provide an accurate activation temperature, this circuit will turn on a heating unit or other device when the temperature drops below the trip point set by R2. Use a 10k resistor in place of the thermistor to calibrate it for 32°F activation.

The vertical position of the thermistors, and the threshold trim control (R1), will affect how sensitive the circuit is to a temperature differential. The timer control (R2) will affect how often the system cycles as the room approaches temperature equilibrium. Although I'm sure a bit of trial-and-error adjustment will be necessary, for a single floor, the thermistor connected to the 12-volt supply should be placed near the ceiling, but away from the fan, and the other thermistor should be placed beneath it, a few feet above the floor.

—David L. King, Chicago, IL

Although David didn't provide more information on the solid-state relay he used, that's not too much of a drawback since you'll have to specify one to meet your own needs anyway. Just find one that handles the load current you have in mind, and requires a 12-volt DC input signal.

The circuit might be useful for me. I have gable fans, controlled by a thermostat, that remove hot air from my attic when the temperature in the attic is high. They work on the theory that there is cooler air under the eaves that will replace the hot air. Of course, if the air entering the eaves isn't that much cooler, it's hardly worth keeping the fans on. The circuit could keep the fans from activating unless it's truly beneficial.

FREEZE SENSOR

This circuit activates a heater to hold the temperature a little above 32°F. I use it during Northern Michigan winters to prevent freezing in water pipes, etc.

Diodes D3 and D4, which are forward biased, establish an operating voltage of about 1.65 volts across the bridge. That ensures that the small thermistor bead operates without any appreciable self-heating.

The diodes at the output of the 741 ensure crisp, sure turn-on operation. Capacitor C2 was added to prevent relay chatter or buzz as the circuit slowly comes on. Make sure, for heater applications, that the relay contacts can handle the current required by your heater. Also, precision (1%-tolerance) resistors should be used for the bridge circuit.

Be careful with the fine thermistor wires. I used small heat-shrink tubing and epoxy to attach it to an old ball-point-pen case so the thermistor just protrudes out one end. At the other end, I attached approximately 6-feet of 2-conductor cable with an RCA plug to mate with J1. In operation, don't position the probe directly in front of or too close to the heater, as that causes a short cycling rate.

For quick calibration, replace the thermistor assembly with a 10K 1% resistor connected across an RCA phone plug, then set the 15-turn trimmer potentiometer, R2, to just light LED1. The resistor simulates the thermistor's value of approximately 10K at 32° F. That way you don't have to wait for freezing temperatures to set the unit.

—Roger W. Hamel, Cedarville, MI

Very nice work. I would recommend that the calibration resistor replace the thermistor at the far end of the cable, not at the bridge end. The reason for that is to take the cable resistance into account during calibration. Also, be sure to use heavy-gauge wire for all AC connections as appropriate.

THERMOSTAT CIRCUIT

I have been experimenting with temperature-control circuits and came up with this differential thermostat. With the component values shown (see Fig. 3), my thermostat operates between 32° and 86°F.

I have used two sections of an LM324 quad op-amp configured as comparators. The reference voltage of each comparator is set by two multi-turn potentiome-

(Continued on page 70)

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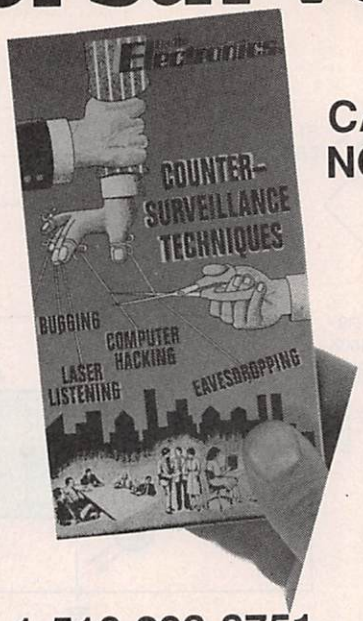

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Build a Telephone-Line Simulator

BY THOMAS E. BLACK

Use it to test or demonstrate telephone equipment, to set up your own mini telephone system, and more.

Mr. Watson, come here; I want you. Ever since those famous words were spoken over the first telephone instrument by Alexander Bell, we've discovered unlimited uses for the telephone. Now we can communicate not only with our trusty telephone, but we can also use PC modems, Fax machines, answering machines, and the like.

But those gadgets have become complicated, and they occasionally break down. Testing them can be a real chore, unless you have access to multiple phone lines so that you can conveniently place test calls. Of course, there are commercial phone-line simulators that can be used instead of a phone line, but they can cost several hundred dollars.

Well, with *Ring-It!* you can now have a complete telephone system in a box. Forget about tying up your telephone line; simply plug in the telephone device that you want to check, and do your tests.

All of the standard telephone-system features that you need are supported. You can ring-up telephones, Fax machines, modems, and answering machines. Just about anything that you can connect to a standard phone line can be activated with Ring It!.

Because the standard telephone-call progress sounds are generated (dial tone, busy signal, ringing, etc.), you can even use Ring-It! to demonstrate telephone equipment. Don't ever tie up your home or business phone again while you show off your telephone products. In fact, with Ring-It!, it's almost impossible to tell that you aren't using a real phone line.

You can even connect a pair of standard phones and create a simple phone system. In that configuration, the phone on line 2 automatically rings when the phone on line 1 is picked up. The lines are connected when both phones are in use, and the conversation ends by hanging up.

The flexibility of Ring-It! is provided by a single-chip microprocessor, which allows us to keep the component count to a minimum. An on-board ring generator provides the precise voltages required to activate the phone equipment, and a call-progress tone-generator IC creates the normal telephone-related sounds (busy signal, ring signal, etc.).

Features. Ring-It! has five different operational modes that can be invoked through one of the front-panel-mounted push switches. There is even an LED readout that displays the current mode that is in use.

The LED display is used to indicate mode, cycle time, and dialed-digit information. Its decimal point is illuminated only when the mode or cycle time is shown; a decoded DTMF (Dual-Tone Multi-Frequency) digit is shown as a value without the decimal point.

The five modes can be invoked by pressing the Mode switch; the active mode is shown in the LED display. The modes are summarized as follows (the bracketed value indicates the corresponding LED display):

- [n.] Normal Ring Mode
- [A.] Automatic Ring Mode
- [b.] Beep Tone Mode
- [c.] Cycle Ring Test Mode
- [d.] Dumb Mode

The normal ring mode is used when you want standard telephone-system emulation. When you take the line-1 (main) phone off-hook, a dial tone is heard. If you do nothing for twenty seconds, a "reorder" sound is heard. If you tone dial any seven-digit phone number, the line-2 (test) phone will start to ring. When line 2 answers, the front-panel connect LED will light up.

While you press the DTMF keys of your phone, the corresponding digit will appear in the LED display for up to two seconds. Because of limitations in our display, the * tone is shown as "A" and the # key is shown as "P."

If you attempt to ring the test line and it is off-hook, then a busy signal will be heard. Please note that because it is a one-way device, line 2 can not be used to ring line 1.

There are some shortcuts in the normal mode that can be used to ring the test line. For example, pressing the main phone's DTMF * key will immediately start the ring request. The front-panel Ring switch will also start the ring cycle, which can be used if the main line's phone is not DTMF compatible.

The normal mode is perfect for

demonstrating telephone equipment such as answering machines, Fax systems, voice mail, modems, and more. Because the standard call-progress audio tones are heard, your demonstration will appear more natural to your audience and equipment.

The automatic ring mode is similar to the normal ring mode, except that in the automatic mode, ringing begins immediately after the line-1 phone is picked up. That operation is sometimes called a "Ring-Down line" by phone-system manufacturers. If either line is off-hook when the other is picked up, the two lines will be automatically connected together.

The automatic mode, besides being used to test phone equipment, is also perfect for use as a front-entry intercom for home or office use. Place a phone near you and one near your entry. Be sure to post a note near the entry phone that instructs your visitors to "lift the receiver for assistance."

The beep tone mode is specially designed for cycle testing answering machines and other types of telephone equipment. That mode does not start until the Ring button or the DTMF * key is pressed.

It is not necessary to have the line-1 phone off-hook during the beep mode. Whenever line 2 is taken off-hook the two lines will be automatically connected together and a series of repeating test tones will be generated.

During the beep mode, the test line automatically rings after a short adjustable delay (the delay is skipped on the first cycle). If the test line is answered, staggered beep tones are played. Those tones have been designed to keep a voice-controlled answering machine from hanging up. The ring-up cycle repeats (after the requested delay) until the mode is canceled by pressing the Mode switch.

For example, if the delay is set for thirty seconds, the device being tested will be rung-up thirty seconds after the last answer/disconnect cycle. The test tones will be played as long as the test line is off-hook. If the test line goes on-hook, the delay cycle starts up again.

The cycle ring-test mode provides most of the features of the beep mode, except that in the former, the beep tones are not played and a phone must be plugged into the main line. To start the cycle you must pick up the phone attached to line 1. Again, if either line is off-hook when the other is picked up, the two lines will be automatically connected together.

When line 2 answers, your conversation may begin. If line 2 hangs up and the main phone remains off-hook, the test line is automatically rung up after the delay time. That cycle repeats until the main phone is hung up.

The dumb mode provides a silent talk path and allows a manual ring. You will not hear any call progress tones; however, you can converse normally.

Line-2 ringing is controlled by using the Ring switch or the main phone's * key. The ring signal will follow the key presses. Unlike the other modes, they do not continue to ring when the keys are released.

The dumb mode is perfect for testing the basic operation of equipment. And because you can control the duty cycle (cadence) of the ring signal, non-standard equipment can be tested for ring operation.

TABLE 1—DTMF TONE PAIRS

Low Group	High Group		
	Column 0 1209 Hz	Column 1 1336 Hz	Column 2 1477 Hz
Row 0, 697 Hz	1	2	3
Row 1, 770 Hz	4	5	6
Row 2, 852 Hz	7	8	9
Row 3, 941 Hz	*	0	#

Note: In 16-digit DTMF, there is an eighth tone (1633 Hz, Column 3).

How it Works. A schematic diagram of the Ring-It! telephone-line simulator is shown in Fig. 1. The circuit's intelligence is provided by U9, a PIC16C57-XT/P microcontroller IC. That chip is a member of Microchip Technology's family of high-performance, low-cost 8-bit microcontrollers.

A microcontroller is a small, general-purpose computer chip that contains a microprocessor-type, Central Processing Unit (CPU), similar to the one found in your personal computer. However, it also incorporates Random-Access Memory (RAM), Read-Only Memory (ROM), and digital Input/Output (I/O) lines. In other words, it's a complete computer system that is housed in one IC.

Because the PIC16C57-XT/P is a computer, it needs software to operate. The internal ROM holds the software program, which is called firmware. The firmware is permanently programmed and is non-volatile, which means that it isn't lost when power is turned off. The RAM is used by the program for storing temporary data variables and state conditions. Although there are only 72 bytes of RAM, it's more than enough for our application.

The firmware-controlled functions, such as ring generation, tone detection, LED and relay control, etc., are event-driven, so all features work seamlessly together. Unlike simple loop-controlled programs, our software design uses a time-based task scheduler to control the hardware operations.

Installing the firmware into ROM involves a process called prom burning, and special equipment is used to perform that task. For those without the required equipment or expertise, a preprogrammed microcontroller is available from the source given in the Parts List. On the other hand, for those of you who want to "roll-your-own," we have made the compiled object-code file, in Intel 8-bit merged (INHX8M) format, available on this magazine's BBS (516-293-2283, 8N1). Although the software is copyright protected, you are free to download a copy for your personal use. For other uses, consult the source given in the Parts List.

Getting back to the circuit, U9's RTCC input is used to emulate an adjustable-time-delay timer. The frequency of the oscillator formed by

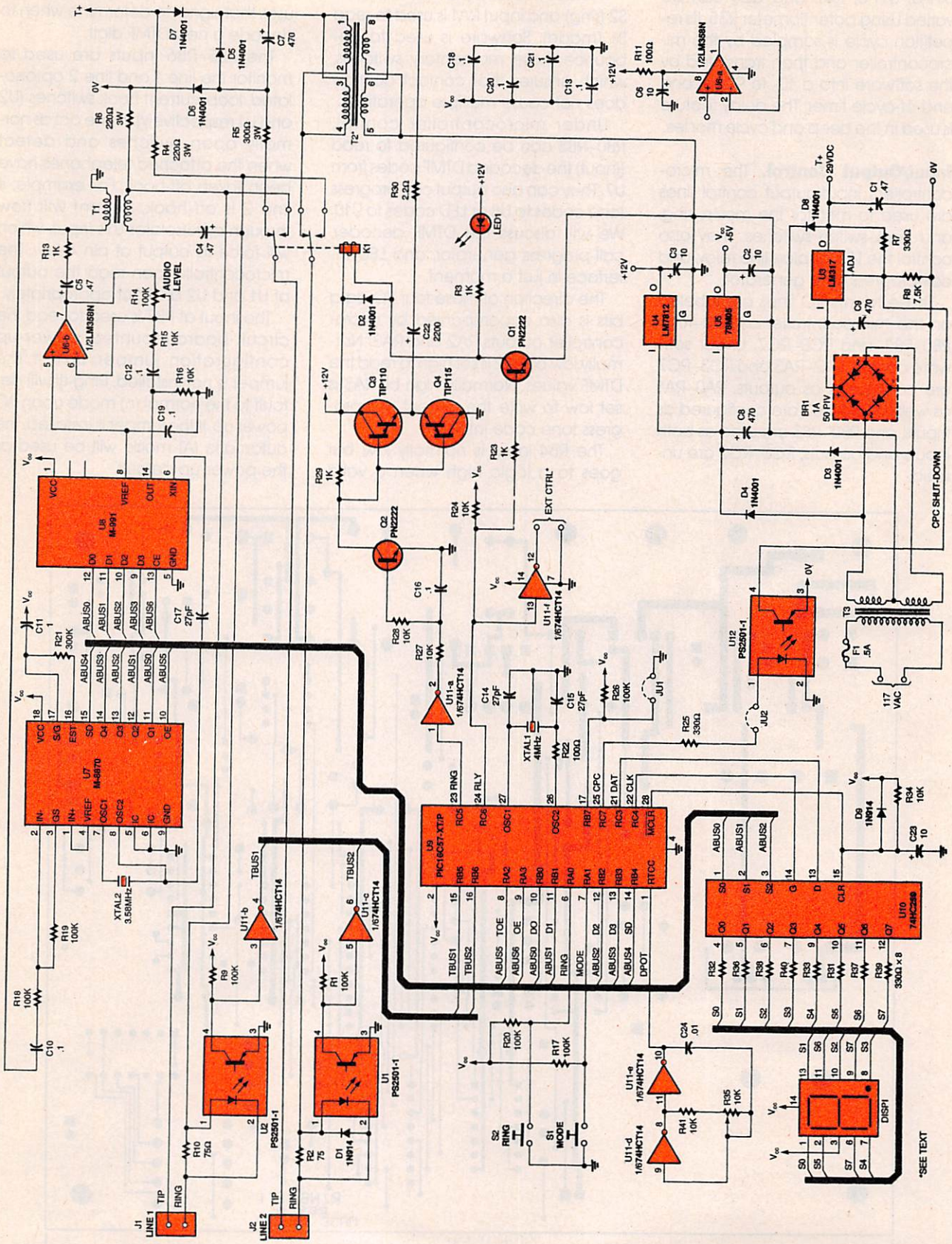

Fig. 1. Here's the complete schematic for the Ring-It! telephone-line simulator. The microcontroller (U9) gives the unit its sophistication but keeps circuit complexity to a minimum.

U11-d, U11-e, R41, and C24 can be varied using potentiometer R35. Its repetition cycle is sampled by the microcontroller and then translated by the software into a 10- to 90-second end-of-cycle timer. The delay feature is used in the beep and cycle modes.

Input/Output Control. The microcontroller's input/output control lines are used to monitor the mode, ring, and hook-switch switches. They also control the LED display, line relay, and call-progress tone generator.

Those twenty I/O lines are labeled on the microcontroller as RA0–RA3, RB0–RB7, and RC0–RC7. Under software control, RA2–RA3 and RC3–RC7 are configured as outputs, RA0–RA1 as well as RB4–RB7 are configured as inputs, and RB0–RB3 are used as both inputs and outputs; RC0–RC2 are unused.

Microcontroller-input RA0 monitors S2 (ring) and input RA1 is used to read S1 (mode). Software is used to debounce those momentary switches, which ensures that contact bounce does not cause multiple operations.

Under microcontroller control, RB0–RB3 can be configured to read (input) the decoded DTMF codes from U7. They can also output call-progress tone codes to U8 or LED codes to U10. We will discuss the DTMF decoder, call-progress generator, and LED interface in just a moment.

The direction of those four I/O data bits is also accompanied by microcontroller outputs RA2 and RA3. Normally low bit RA2 is set high to read the DTMF values. Normally high bit RA3 is set low to write the current call-progress tone code into U8.

The RB4 input is normally low, but goes to a logic high when a valid DTMF is detected. The microcontroller uses that signal to determine when to decode a new DTMF digit.

The RB5–RB6 inputs are used to monitor the line 1 and line 2 optoisolated, loop-current hook switches (U2 and U1 respectively). Those act as normally open switches and detect when the attached telephones have been taken off-hook. For example, if line 2 is off-hook, current will flow through optoisolator U1's input, which will force its output at pin 4 low. The microcontroller can read the output of U1 and U2 and act appropriately.

The input at RB7 is used to read the circuit-board mounted, power-up configuration jumper, JU1. If the jumper is not installed, Ring-It! will default to the normal (n) mode upon AC power up. If the jumper is installed, the automatic (A) mode will be used as the power-up default.

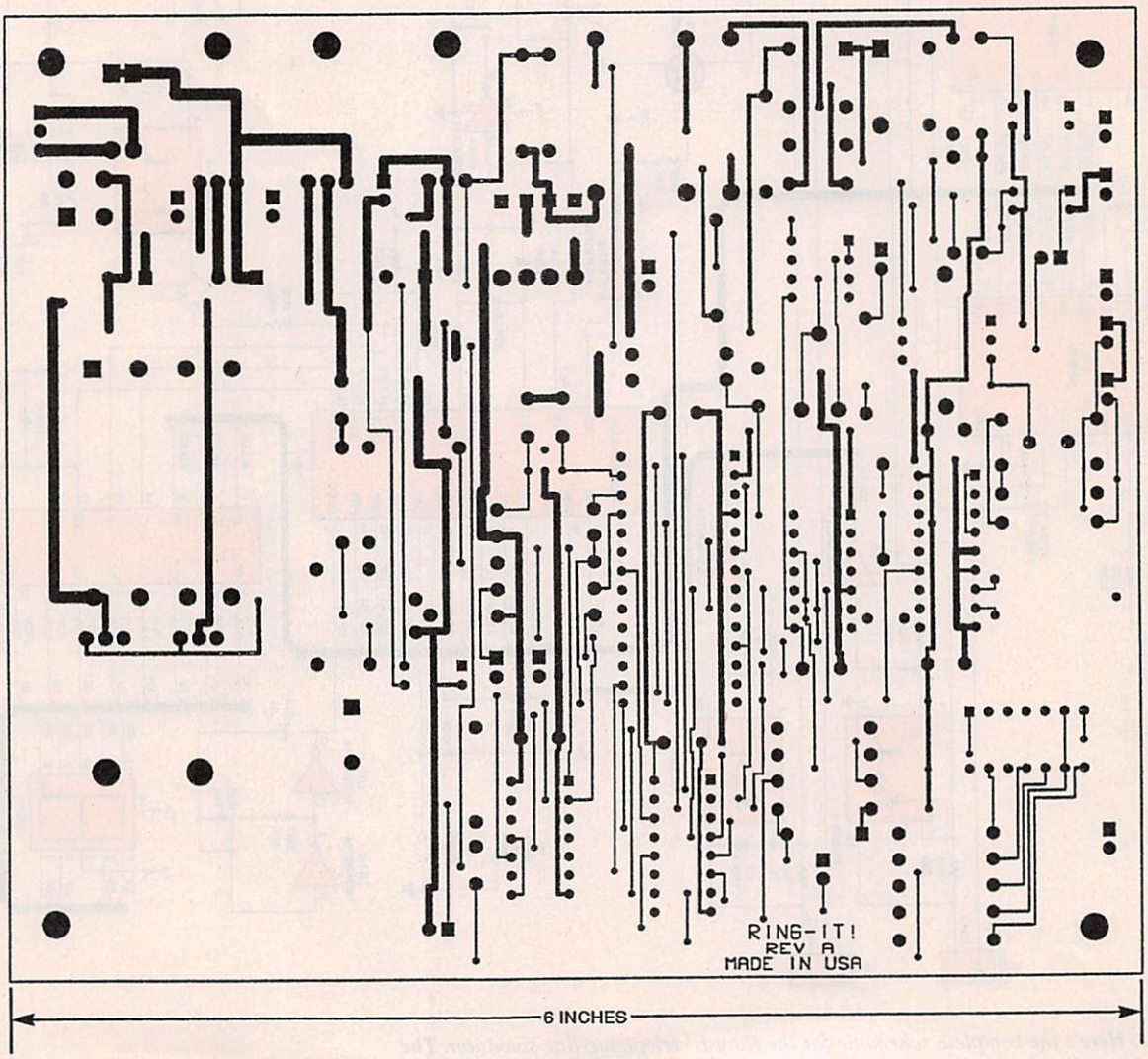

Fig. 2. The bulk of the circuitry is located on the main PC-board. The foil side of that board is shown here.

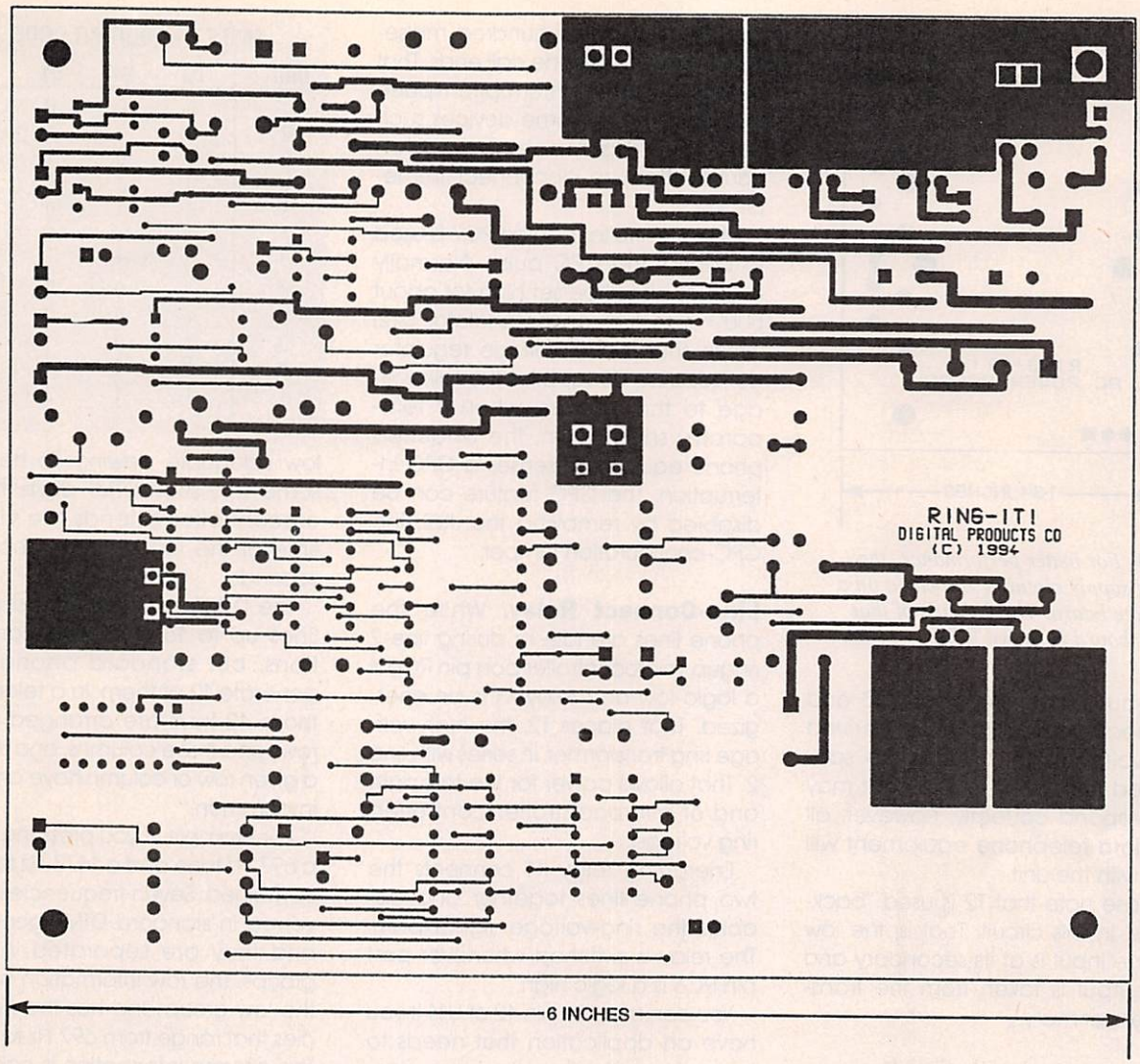

Fig. 3. Here is the foil-pattern for the main board's component side.

The RC0–RC2 port bits are unused. The RC3–RC7 bits are configured as outputs and are used to control the line relay, ring-voltage generator, and CPC pulse. When used in conjunction with the RB0–RB3 output bits, they can send new LED display values to U10, a 74HC259 8-bit addressable latch.

LED Display. Microcontroller output bits RB0–RB2 and RC3–RC4 are used to control the single-character, seven-segment LED display, DISP1. (Note that the display actually has eight segments if you count the decimal point.) Like most LED readouts, it was originally designed for displaying numbers 0–9. But by using a combination of upper and lowercase, and a little imagination, it is possible for us to get a limited number of alphabetic characters.

We use the alpha characters to display the current test mode and some of the DTMF tone values (* and #). As mentioned earlier, the * and # DTMF characters are not displayable, so we show them as "A" and "P."

The LED segments are enabled by the addressable latch, U10. The microcontroller uses RB0–RB2 to address which of eight LED segments are to be modified. The RC3 output selects how the LED segment will be illuminated (on/off) and RC4 latches the addressed value.

To update the display, the microcontroller must step through all eight bits of U10 and set or clear them as required. Of course, that is done so fast that it appears to happen as a single action. Eight 330-ohm series resistors are used to safely limit the current into each segment of the display.

Ring Generator. Microcontroller output-bit RC5 is used to provide the 20-Hz frequency used by the step-up ring-voltage transformer, T2. Because American and many foreign phone companies use 20-Hz ring frequencies, we have provided the same in the Ring-It! design. Note that some low-end commercial telephone simulators use 60-Hz ring frequencies because they are easily derived from the AC power line. However, some phone equipment will not operate correctly with them. To maintain compatibility with all standard telephone equipment, a software-controlled, standard 90-volt AC, 20-Hz ring generator is used.

The 20-Hz generator provides reliable ring activation for at least two standard telephones. The high voltage (approximately 90 volts AC) is generated by T2, a step-up ring-voltage transformer, which is driven by

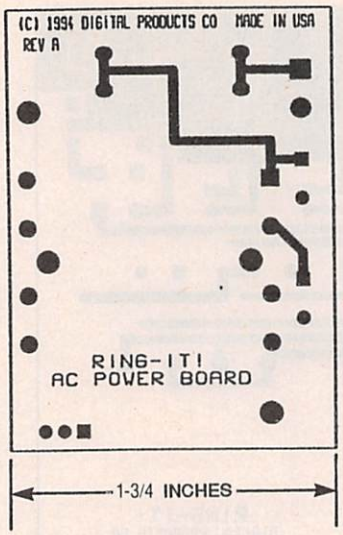

Fig. 4. For better performance, the power-supply circuitry is located on a separate board. The foil side of that power board is shown here.

push-pull power transistors Q3 and Q4. Because square-wave-derived ring voltages are used, some specialized telephone equipment may not respond correctly. However, all standard telephone equipment will work with the unit.

Please note that T2 is used "backwards" in this circuit. That is, the low voltage input is at its secondary and the output is taken from the transformer's primary.

Calling-Party Control. To help disconnect some telephone equipment, Ring-It! uses a method called CPC (calling-party control). On most phone lines, the phone voltage is interrupted for a few hundred milliseconds after the phone call ends. That causes a current-interruption pulse that is sensed by some devices such as answering machines, which causes them to disconnect immediately.

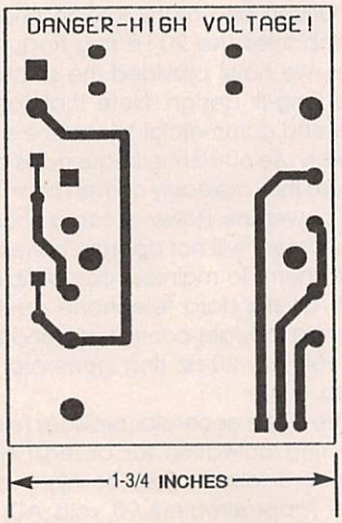

Fig. 5. The component side of the power board is shown here full size.

Microcontroller port bit RC7 is used to control the CPC pulse. Normally low, that bit will be set high for about 500 ms to turn on optoisolator U12, which shuts down voltage regulator U3. Because U3 supplies the talk voltage to the phones, when it temporarily shuts down, the attached phone equipment senses a CPC interruption. The CPC feature can be disabled by removing the JU2, the CPC-configuration jumper.

Line-Connect Relay. While the phone lines are idle or during line-2 ringup, microcontroller port pin RC6 is a logic low and relay K1 is de-energized. That places T2, the high-voltage ring transformer, in series with line 2. That allows power for the talk path and/or microcontroller-controlled ring voltage.

Energizing relay K1 connects the two phone lines together and disables the ring-voltage signal path. The relay is switched whenever port pin RC6 is a logic high.

You can monitor pin 12 of U11 if you have an application that needs to know when the two lines are connected. That signal is available at the external-control output (labeled EXT CTRL on the schematic) and is a logic low when the relay is energized. It could be used to turn on an external audio source, relay, or whatever. It is a TTL-compatible signal and can sink or source about 10 mA.

DTMF Decoder. Decoding the dialed phone-number digits is a simple exercise because of the use of the industry-standard M-8870 DTMF tone-receiver for U7. That popular IC is made by the Teltone Corporation, Mitel Semiconductor, and others.

The receiver decodes only DTMF-type telephone digits; rotary-pulse-dialed digits are ignored. The DTMF feature allows you to conveniently test the tone dialing feature of your phone equipment.

As long as a DTMF tone is present the display will show its value; speed dialers may operate too quickly to allow adequate viewing. To help see some very short DTMF digits, the microcontroller extends the viewing time of the last digit for about two seconds.

TABLE 2—FOUR-BIT CODE

DIGIT	D3	D2	D1	D0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0

The DTMF encoding standard defines up to 16 dual-tone combinations, but standard phones only generate 12 of them. In a telephone, those 12 keys are arranged in four rows and three columns, and those in a given row or column have one tone in common.

For example, if you press the 3 digit, a 697-Hz tone and a 1477-Hz tone are combined. Seven frequencies are involved in standard DTMF generation and they are separated into two groups. The row information is called the low group and has the frequencies that range from 697 Hz to 941 Hz. The column information is called the high group and it covers frequencies from 1209 Hz to 1477 Hz. Table 1 shows the layout of the DTMF tone pairs.

DTMF Decoder U7 incorporates switch capacitor filtering to separate the low- and high-frequency tone groups. Qualified DTMF digits are decoded into a four bit code as shown in Table 2.

Call-Progress Tone Generator. Phone-company generated sounds that are heard on the phone, such as dial tone, busy signals, telephone ringing, etc., are considered comfort tones. They are present only to confirm the progress of the telephone call. Although foreign countries use similar tones, they are slightly different than those heard in the U.S. In Ring It!, the comfort tones are largely produced using U8, a Teltone Corporation M-991 call-progress tone-generator chip.

Actually, Ring-It uses both software

PARTS LIST FOR THE TELEPHONE-LINE SIMULATOR

SEMICONDUCTORS

U1, U2, U12—PS2501-1 optoisolator (NEC), integrated circuit
U3–LM317T 1.2—37-volt adjustable regulator, integrated circuit
U4—LM7812 12-volt regulator, integrated circuit
U5—LM7805 5-volt regulator, integrated circuit
U6—LM358N low-power dual op-amp, integrated circuit
U7—M-8870, CMOS DTMF receiver (Teltone Corporation), integrated circuit
U8—M-991, CMOS call-progress tone-generator (Teltone), integrated circuit
U9—PIC16C57-XT/P CMOS 8-bit microcontroller (Microchip Technology), integrated circuit
U10—74HC259 or 74HCT259 CMOS addressable latch, integrated circuit
U11—74HCT14 CMOS hex inverter, integrated circuit
Q1, Q2—PN2222 NPN transistor
Q3—TIP110 NPN Darlington transistor
Q4—TIP115 PNP Darlington transistor
BR1—1 amp, 50 PIV, bridge rectifier
D1, D9—1N914 or 1N4148 general-purpose silicon diode
D2–D8—1N4001 silicon rectifier diode
DISP1—7-segment LED, 0.56-inch, common anode, RH decimal point
LED1—Green LED, T1¾ size

RESISTORS

(All fixed resistors are ¼-watt, 5% units unless otherwise specified.)
R1,R9 ,R17–R20, R26—100,000-ohm
R2, R10—75-ohm
R3, R13, R23, R29—1000-ohm
R4, R6—220-ohm, 2-watt, metal oxide
R5—300-ohm, 2-watt, metal oxide
R7, R25, R31–R33, R36–R40—330-ohm
R8—7,500-ohm
R11, R22—100-ohm
R12—not used
R14—100,000-ohm, trimmer potentiometer, PC mount
R15, R16, R24, R27, R28, R34, R41—10,000-ohm
R21—300,000-ohm
R30—2.2-ohm
R35—10,000-ohm, potentiometer, panel-mount, linear-taper

CAPACITORS

C1, C4, C5—0.47-µF, 50-WVDC,radial-lead, electrolytic
C2, C3, C6, C23—10-µF, 16-WVDC, radial-lead, electrolytic
C7, C8—470-µF, 35-WVDC, radial-lead, electrolytic
C9—470-µF, 50-WVDC, radial-lead, electrolytic
C10–C13, C16, C18–C21—0.1-µF, 50-WVDC, radial-lead, monolithic-ceramic
C14, C15, C17—27-pF, ceramic-disc, see text
C22—2200-µF, 16-WVDC, axial-lead, electrolytic
C24—0.01-µF, radial-lead, polyester

ADDITIONAL PARTS AND MATERIALS

K1—DPDT relay, 12-VDC coil, DIP Package, P&B T83S11D212-12, Aromat DS2YE-S-DC12V, or similar
S1, S2—SPST switch, normally open, momentary-contact pushbutton, panel mount
T1—Telephone-coupling transformer, 600-ohm:600-ohm, PREM Magnetics SPT130 or equivalent
T2—Ring transformer, split bobbin, dual 115-VAC primary to dual 6.3-VAC secondary, Magnetek/Triad FS12-200 or equivalent
T3—AC power transformer, split bobbin, dual 115-VAC priamary to dual 14-VAC secondary, Magnetek/Triad FS28-200 or equivalent
XTAL1—4.00-MHz crystal, HC18 or HC49 package, or 4.00-MHz ceramic resonator, see text
XTAL2—3.5795-MHz crystal, HC18 or HC49 package J1, J2—RJ11 6/2 or 6/4 modular telephone jacks
F1—0.5-amp fuse, 5 × 20 mm
Printed-circuit boards, IC sockets, right-angle socket, fuse clips (Keystone 3521 or similar), AC line cord and plug, enclosure, heat sinks, wire, solder, etc.

The following parts are available from: Digital Products Company, 134 Windstar Circle, Folsom, CA 95630; Tel./Fax:-916-985-7219: Complete Ring-It! kit, including pre-programmed microcontroller, PC-board set, relay, transformers, IC's, resistors, capacitors, seven-segment LED socket, documentation, etc. (case not included); $145.00. Basic Ring-It! kit, including PC-board set, programmed microcontroller, complete documentation; $53.95. Transformer/relay kit, including K1, T1, T2, and T3; $38.95. Hard-to-get IC kit, including U1, U2, U7, U8, U10, U11, U12; $24.50. Printed-circuit board set; $34.95. Programmed PIC16C57-XT/P microcontroller (licensed copy); $20.00. Seven-segment LED socket; $3.75. Complete documentation package with schematic; $6.00. Software disk, RI.OBJ object code, INHX8M format (disk provides single-use license; specify 3.5- or 5.25-inch size); $8.00. Please add $6.50 ($14.00 Canada) to all kit orders and $5.00 ($9.50 Canada) to all component/documentation/software orders for shipping and handling. Other countries, please write/Fax for shipping information. California residents must add local sales tax. Checks, money orders, Visa, Master Card, and Discover accepted; checks must clear before shipping. Payment in U.S. funds only.

and hardware to create the call-progress tones. Under microcontroller control, U8 can simulate a number of the audio tones that are normally heard while using a phone. Some of the sounds are composed of two frequencies mixed together; others are simple single tones. Table 3 lists a few of the four bit codes that are sent to U8 to create the call progress sounds.

Because the tones may need to be gated on and off, such as in a busy-signal pattern, the microcontroller must occasionally get involved. To create the cadence heard in the ring and busy tones, the microcontroller must set pin 13 of U8 to a logic high to mute the audio during the silent periods. Our task-based software program is used to schedule those time sensitive operations.

The progress tones are generated whenever pin 13 of U8 is at a logic low. Because the four-bit code is latched at the falling edge of waveform presented to pin 13 of U8, the RB0–RB3 bits can be immediately freed for use by the DTMF receiver or the LED display latch.

Power Supplies. There are three different low-voltage, DC power supplies in the design. Common three-

TABLE 3—CALL-PROGRESS-SOUND CODES

Tone	Frequency	D3	D2	D1	D0
Dial	350/440	0	0	0	0
Special	400/off	0	0	0	1
Alert	440/off	0	0	1	0
Ring	440/480	0	0	1	1
Busy	480/620	0	1	1	0

terminal IC regulators are used to derive the required digital, analog, and talk-path power.

The digital logic and analog circuitry is powered by LM7805 (U5) and LM7812 (U4) fixed voltage regulators. Those popular devices provide excellent voltage regulation and have internal over-current and over-temperature protection.

The power supply uses a center-tapped, full-wave rectifier design that begins with diodes D3 and D4. Capacitor C8 is used as a bulk filter to the raw DC (about 16–20 volts DC) before being applied to the IC regulators. Regulator U5 provides 5 volts DC for the digital logic and U4 provides 12 volts DC for the relay and analog circuitry.

We only need a few hundred milliamps of current to operate the circuitry, so either the 0.5-amp (78Mxx) or 1-amp (78xx) type regulators can be used. Because they are series-pass-type regulators, they can run very warm while in operation. You must use a heatsink on U5 to maintain a comfortable operating temperature.

The simulated phone-line talk-path power ("battery" voltage) is provided by an LM317 IC (U3), another popular three-terminal regulator. Unlike the 78xx-series regulators, that device can provide an adjustable range of voltages as selected by resistors R7 and R8. The chosen resistor values set the output to about 29 volts DC. Although most phone lines use a 48-volt DC talk voltage, our 29-volt DC supply will work correctly with all standard telephone equipment.

The talk supply begins with rectifier

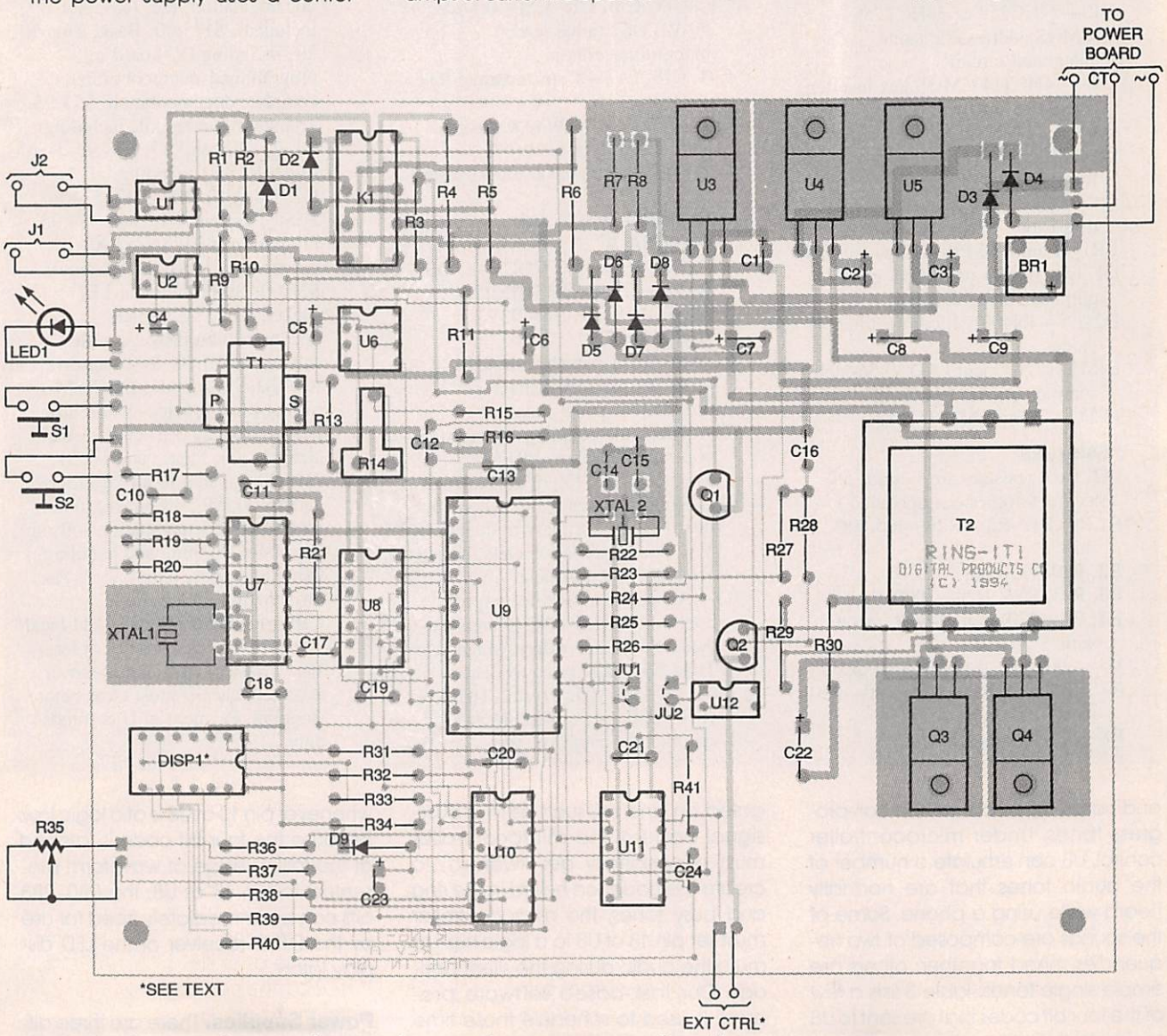

Fig. 6. Use this parts-placement diagram when mounting components on the unit's main board.

BR1, the full-wave bridge, which converts the incoming low-voltage AC to unregulated DC (about 36-volts DC). Capacitor C9 is used to bulk filter the raw DC voltage before it is applied to the regulator.

You may also notice that the regulator's ADJ terminal is connected to optoisolator U12. That optically isolated switch is used to shut off the voltage regulator during the CPC (calling-party control) pulse. When enabled by the microcontroller, U12 reduces the talk voltage to about 1.2-volts DC, which is low enough to simulate the CPC condition.

Construction. Although Ring-It! is a fun project to assemble, it certainly is *not* for beginning electronics-kit builders. If you don't have experience with CMOS IC's and PC-board assembly, please obtain help before starting.

We have provided PC foil patterns for the main board (Figs. 2 and 3) and the power board (Figs. 4 and 5) so that you can etch your own boards if you wish. You may find it more convenient to purchase a commercial-quality PC board from the source listed in the Parts List. If you do purchase the board, *do not* clean it before soldering; the boards available from the supplier have a special tin plate coating that prevents oxidation.

The parts-placement diagrams for the two boards are shown in Fig. 6 (main board) and Fig. 7 (power board). The AC transformer (T3) and fuse (F1) are installed on the power board; the bulk of the remaining components, including all of the digital circuitry, are installed on the main board. Among other things, the two board approach was used to promote safety. Always exercise caution when working near the power board's high voltages.

Use a 25–47-watt soldering-iron; temperature-controlled irons set to 700°–800° work best. Do not use a soldering gun! Use only rosin-core solder with a 60/40 tin/lead content.

Part substitutions are not recommended. Use the components shown in the Parts List and only substitute those that you know are exact replacements. For correct cycle-delay operation, do not substitute U11 with a non-HCT type IC.

Use care in handling the IC's; they are CMOS devices and are sensitive to static. They can be damaged through mis-handling!

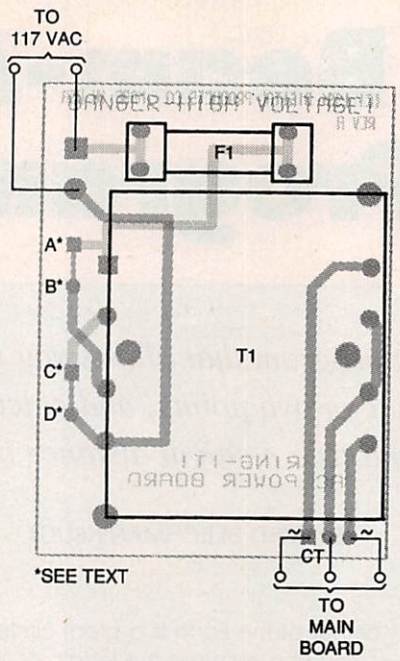

Fig. 7. The power board is set up for 117-volt operation, but can be modified for 220-volt use by cutting traces and adding jumpers as described in text.

Component XTAL1 can be either a quartz-type crystal as specified, or a ceramic resonator. Delete capacitors C14 and C15 if using a ceramic resonator with built-in capacitors.

Use a socket to mount the microcontroller (U9). A special right-angle IC socket (made by Vertisocket and available from Digi-Key Electronics, 701 Brooks Ave. South, PO Box 677, Thief River Falls, MN 56701-0677; Tel. 800-344-4539) is used at DISP1 to vertically mount the seven segment LED for proper viewing. Sockets should be used for the other IC's, but are not absolutely required. Install two-pin headers with shorting blocks at the JU1 and JU2 positions.

Transistors Q3 and Q4 as well as the three voltage-regulators (U3–U5) should be anchored to the PCB with 4-40 × ¼-inch machine screws and nuts. Use a heatsink and thermal grease (heatsink compound) on U5, the 7805 regulator. Please note that it's normal for that regulator to feel warm during operation.

Install and label LED1 as CONNECT on your enclosure's front panel. Wire it to the PC board using 5-inch-long pieces of 22–24 AWG stranded wire. Be sure to observe proper polarity.

Install and label S1 as MODE and S2 as RING on your enclosure's front panel. Again, connect them to the PC board using 5-inch-long pieces of 22–24 AWG stranded wire.

Install modular jacks at the J1 and J2 positions. Each jack's green wire is connected to the square pad on the board and the red wire is connected to the other pad. Cut off any extra wires that may be on the connector.

Install potentiometer R35 on the rear panel of your enclosure and label it as DELAY. Connect the potentiometer to the appropriate points on the PC board using stranded wire.

If after testing your finished project you find that the delay control works backwards, merely reverse the connection to the potentiometer's wiper. If installed correctly, the delay time should increase as the control is moved clockwise.

If you find that you can not achieve a 10–90 second delay range, then C24 or R35 are out of tolerance (check them). Although the software has been designed to allow correct operation over a wide range of component tolerances, it may be necessary to try different components at U11, C24, or R35 to get the desired range.

The power transformers, T2 and T3, are split bobbin types with dual 50/60Hz primaries and secondaries. Using standard power transformers is not recommended, especially at the T2 location. Such transformers are available from sources such as Microtran, Magnetek/Triad, Signal Transformer, PREM Magnetics Inc., and others.

Be sure to observe the orientation of the transformers. On T1, match the "P" and "S" references on the parts-placement diagram. It may be necessary to cut off the frame's mounting tabs on some transformer designs. Install T2 and T3 so that the transformer's pin 1 is in the square pad.

The power board layout is already set for 117-VAC operation. However, it can be converted to 230-VAC operation for use outside the U.S. For 230-VAC operation perform the following cuts and jumps: Cut the trace between the pads designated A and B in Fig. 7, cut the trace between the pads designated C and D, and add a jumper between pads B and C.

(Continued on page 90)

A DX Beam-Aimer Program

Here's a nifty program that allows you to enter latitude and longitude of two points, and calculates the true direction and true nautical distance between them.

BY FRED BLECHMAN K6UGT

Whether you are a ham-radio operator or a serious short-wave listener, your antenna is one of the most important elements of your radio equipment. Furthermore, since most antennas are directional, for long-distance communication you need to "aim" your antenna properly.

This is not as simple as it sounds, since the Earth is a sphere and flat maps are notoriously inaccurate. When I went through navigation courses as part of my flight training to become a Naval Aviator, I became aware of the compromises made in trying to reduce a spherical surface (the Earth) to a flat sheet of paper (a map). It just can't be done with accuracy over long distances. If the angles are correct, then the distances are distorted, and vice-versa.

Probably the most common map of the world, or large areas of the Earth, is a Mercator Projection, where all the latitude (horizontal) and longitude (vertical) lines are shown straight and perpendicular to each other. While this is easy to read, it is notoriously inaccurate for navigational purposes. Although the old expression that "the shortest distance between two points is a straight line" is certainly true in spatial relations, it is totally false on most maps.

In the case of a spherical object, which the Earth approximates, the shortest distance along the surface is the arc of "a great circle." The intersection of the surface of the Earth with a flat plane that passes through the center of the Earth is a great circle.

You can estimate the length of an arc on a great circle by placing a string between the origin and the destination on a globe, but the accuracy is limited by the size of the globe. However, the DX Beam-Aimer Program that we'll present in this article is accurate to a small fraction of 1 percent! It can be used to determine the shortest distance and direction between virtually any two points on Earth, given the location of each. Many charts are available that give the distance and direction between major cities-but not necessarily from where you are to where you want to go. With this program, you can "start" and "stop" anywhere!

While hams and SWL's will benefit the most from the program, it can also be used for long-distance boating and aircraft flight planning. And, although the program is written in IBM PC GWBASIC, it has intentionally been designed so it will run on most microcomputer BASIC interpreters with little or no changes.

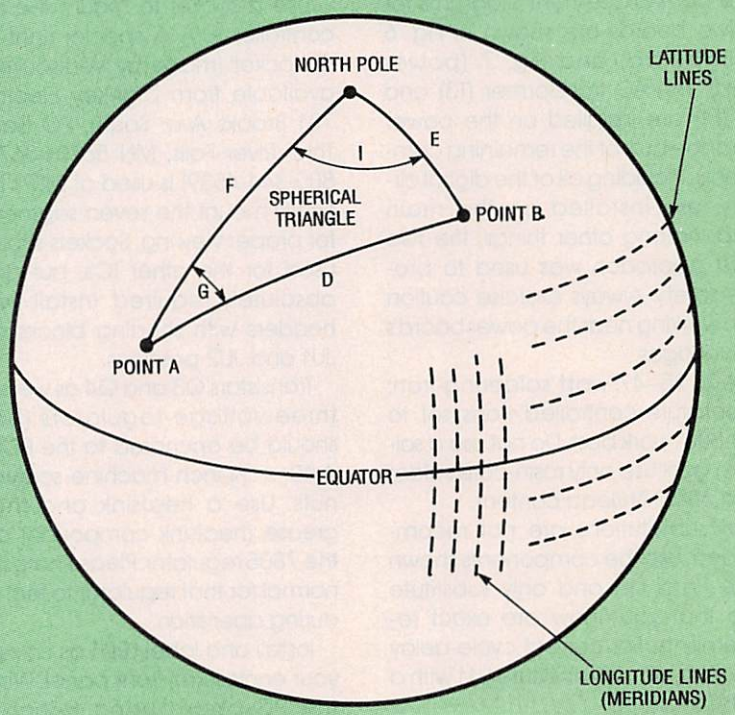

Fig. 1. Since the Earth is a sphere, all paths between points on its surface are really arcs with their origins at the Earth's center.

LISTING 1

```
100 REM ************************************************
110 REM *                "DX Beam-Aimer"                 *
120 REM *  (C) Copyright Fred Blechman 1993 K6UGT        *
130 REM ************************************************
140 DIM  A(11): REM * SET ARRAY SIZE FOR VARIABLES *
150 CLS : PRINT
160 PRINT TAB(14)"*** BE SURE KEYBOARD IS IN CAPS-LOCK MODE! ***":PRINT: PRINT
170 PRINT TAB(20)"GREAT CIRCLE DISTANCE AND DIRECTION"
180 PRINT : PRINT TAB(10)"TO DETERMINE THE SHORTEST DISTANCE FROM POINT A TO"
190 PRINT TAB(10)"POINT B, AND THE DIRECTION FROM A TO B, ENTER THE"
200 PRINT TAB(10)"LATITUDE AND LONGITUDE IN DECIMAL DEGREES OF EACH POINT."
210 PRINT TAB(10)"THESE CAN BE FOUND FROM A MAP, GLOBE OR ENCYCLOPEDIA."
220 REM  * SPHERICAL TRIANGLE HAS ANGLE G AT POINT A,
230 REM    SIDE E OPPOSITE POINT A, SIDE F OPPOSITE POINT B,
240 REM    AND SIDE D OPPOSITE NORTH POLAR ANGLE I. *
250 PRINT : PRINT TAB(10);:INPUT "WHEN READY TO PROCEED, PRESS ENTER";A$
260 CLS : PRINT : PRINT
270 PRINT TAB(14)"*** BE SURE KEYBOARD IS IN CAPS-LOCK MODE! ***": PRINT: PRINT
280 INPUT "POINT A NAME ";A$
290 INPUT "POINT B NAME ";B$
300 REM  * TRIANGLE DIRECTION *
310 PRINT "IS ";B$;" EAST OR WEST OF ";A$;: INPUT " (E OR W)";P$
320 REM  * INPUT LOCATIONS *
330 PRINT : PRINT "LATITUDE OF ";A$;: INPUT A(1)
340 INPUT "NORTH OR SOUTH (N OR S)";J$
350 PRINT "LONGITUDE OF ";A$;: INPUT A(2)
360 INPUT "EAST OR WEST (E OR W)";K$
370 PRINT : PRINT "LATITUDE OF ";B$;: INPUT A(3)
380 INPUT "NORTH OR SOUTH (N OR S)";L$
390 PRINT "LONGITUDE OF ";B$;: INPUT A(4)
400 INPUT "EAST OR WEST (E OR W)";M$
410 CLS : PRINT : PRINT
420 PRINT : PRINT A$;" IS";A(1);"DEGREES ";
430 IF  J$="N" THEN PRINT "NORTH";
440 IF  J$="S" THEN PRINT "SOUTH";
450 PRINT " AND";A(2);"DEGREES ";
460 IF  K$="E" THEN PRINT "EAST"
470 IF  K$="W" THEN PRINT "WEST"
480 PRINT B$;" IS";A(3);"DEGREES ";
490 IF  L$="N" THEN PRINT "NORTH";
500 IF  L$="S" THEN PRINT "SOUTH";
510 PRINT " AND";A(4);"DEGREES ";
520 IF  M$="E" THEN PRINT "EAST"
530 IF  M$="W" THEN PRINT "WEST"
540 PRINT B$;" IS";
550 IF  P$="W" THEN PRINT " WEST";
560 IF  P$="E" THEN PRINT " EAST";
570 PRINT  " OF ";A$
580 REM  * DETERMINE F & E IN DEGREES *
590 F=90-A(1)
600 IF  J$="S" THEN F=F+2*A(1)
610 E=90-A(3)
620 IF  L$="S" THEN E=E+2*A(3)
630 REM  * DETERMINE NORTH POLAR ANGLE I *
640 IF ((K$="W") AND (M$="W")) THEN I=A(4)-A(2)
650 IF ((K$="E") AND (M$="E")) THEN I=A(4)-A(2)
660 IF  I<0 THEN I=-I
670 IF ((K$="E") AND (M$="W")) THEN I=A(4)+A(2)
680 IF ((K$="W") AND (M$="E")) THEN I=A(4)+A(2)
690 IF  I>180 THEN I=360-I
700 IF  I<0 THEN  I=-I
710 PRINT : PRINT "NORTH POLAR ANGLE TO POINT A (";A$;") IS";F;"DEGREES."
720 PRINT "NORTH POLAR ANGLE TO POINT B (";B$;") IS";E;"DEGREES."
730 PRINT "NORTH POLAR ANGLE BETWEEN POINTS IS";I;"DEGREES."
740 REM  * FIND ARC D IN DEGREES *
750 J=.0174533: REM * CONVERTS FROM DEGREES TO RADIANS *
760 REM  * COS D= COS E*COS F + SIN E*SIN F*COS I *
770 A(5)= COS (E*J)
780 A(6)= COS (F*J)
790 A(7)= SIN (E*J)
800 A(8)= SIN (F*J)
810 A(9)= COS (I*J)
820 D=(A(5)*A(6))+(A(7)*A(8)*A(9))
830 REM * ARCCOSINE CALCULATION FOR D FOLLOWS *
840 Y=- ATN (D/ SQR (-D*D+1))+1.5708
850 REM * CONVERT RADIANS TO DEGREES *
860 Y=Y*57.2958:A(10)=Y
870 REM  * CONVERT ARC D DEGREES TO MILES *
880 REM  * 1 DEGREE=60 NAUTICAL MILES ON GREAT CIRCLE *
890 PRINT : PRINT "DISTANCE A-B IS";Y*60;"NAUTICAL MILES (";A(10);"DEGREES)."
900 REM  * STATUTE MILE=1.1515 NAUTICAL MILE *
910 Y=Y*60*1.1515
920 PRINT "DISTANCE A-B IS";Y;"STATUTE MILES."
930 REM  * DETERMINE G IN DEGREES *
940 REM  * COS G=(COS E-COS D*COS F)/(SIN D*SIN F) *
950 X=A(10)
960 A(11)= SIN (X*J)
970 G=(A(5)-(D*A(6)))/(A(11)*A(8))
980 Y=- ATN (G/ SQR (-G*G+1))+1.5708
990 Y=Y*57.2958
1000 IF  P$="W" THEN  Y=360-Y
1010 PRINT : PRINT "DIRECTION A-B IS";Y;"DEGREES CLOCKWISE FROM NORTH."
1020 END
```

Program Summary. The program uses spherical trigonometry to calculate the lengths and angles of a spherical triangle between the starting point, the destination and the North Pole, as shown in Fig. 1. That involves some fairly sophisticated math, but you needn't use any math skills to run the program.

If Point A is the "origin" and Point B the "destination," then side D would be the great circle distance between them, and angle G would be the direction measured clockwise from the north. Side F would represent the angle from Point A to the North Pole, side E the angle from Point B to the North Pole, and angle I would be the angular distance between them at the Pole. These are not important to use the program, but they are used in the solution of the spherical triangle, as you'll see.

To give you a feel of the program's operation, a screen print-out of a typical program session is shown in Fig. 2. It starts with some instructions, then you're asked for the names of the starting point (Point A) and destination (Point B), and their latitudes and longitudes. Longitude "lines" are parallel lines going north and south and passing through the poles. These are "great circles" used to specify angles east or west of Greenwich, England, which is considered zero longitude. A typical longitude, specified in decimal degrees, might be "longitude 115.35 E." By contrast, "latitude" lines run east and west, parallel to the equator, but, with the exception of the equator, they are not great circles. They are used to specify an angle north or south of the equator, such as "latitude 37.5 N."

You'll find that better maps and encyclopedias give locations in latitude and longitude, using degrees and minutes of arc. If a map or encyclopedia is not handy, you can use a globe, but you'll have to estimate the latitude and longitude of Points A and B from the markings on the globe.

The program was designed to handle inputs from either the northern or southern hemisphere, and longitudes east or west of Greenwich. If both the origin and the destination are on the same longitude, you don't need the program at all, since longitude lines are great circles. In such a case, one degree of arc is equal to 60 nautical miles, and the direction between them must be 0 or 180 degrees. To use the program in this circumstance anyway, you may offset either the origin or destination longitude by around one degree; the error that introduces will be insignificant.

Although Earth coordinates are usually specified in degrees, minutes, and seconds of arc for longitude and

TABLE 1—PROGRAM VARIABLES

Name	Use
A(1)	Point A latitude
A(2)	Point A longitude
A(3)	Point B latitude
A(4)	Point B longitude
A(5)	COS (E*J)
A(6)	COS (F*J)
A(7)	SIN (E*J)
A(8)	SIN (F*J)
A(9)	COS (I*J)
A(10)	Arc D; X
A(11)	SIN (D*J)
A$	Point A
B$	Point B
D	Point A to Point B arc; COSine D
E	Point B to North Pole arc
F	Point A to North Pole arc
G	Point A to Point B angle measured clockwise from North; COSine G
I	Angle at North Pole between Point A and Point B
J	Degree-to-radian conversion factor
J$	Point A North/South flag
K$	Point A East/West flag
L$	Point B North/South flag
M$	Point B East/West flag
P$	Triangle direction East/West flag
Y	Arc whose COSine is D; arc whose COSine is G
X	A(10)

TABLE 2—TYPICAL CITIES

Origin	Destination	Approx. Latitude	Approx. Longitude	Nautical Miles	Statute Miles	Direction from North
Los Angeles 34N 118.5W	Hong Kong	22N	112E	6373.69	7339.3	311.83
	Tokyo	35N	140E	4759.13	5480.14	305.228
	Sydney	35S	151E	6544.01	7535.43	240.073
	Zanzibar	8S	40E	8839.03	10178.1	42.2297
	Miami	26N	81W	1995	2297.24	93.6929
	New York	41N	74W	2135.83	2459.41	65.3378
	London	53N	0	4677.82	5386.56	32.7365
	Moscow	55N	37E	5312.82	6117.71	13.7649
	Paris	45N	2E	5062.99	5830.03	37.7492
Tokyo 35N 140E	Sydney	35S	151E	4245.01	4888.13	170.47
	Miami	26N	81W	6462.68	7441.77	38.2432
	Moscow	55N	37E	4118.69	4742.67	323.124
Paris 45N 2E	Hong Kong	22N	112E	5260.23	6057.15	60.6908
	Zanzibar	8S	40E	3782.39	4355.42	136.842
	New York	41N	74W	3217.27	3705.27	294.569
Moscow 55N 37E	New York	41N	74W	4051.52	4665.32	310.315
	Sydney	35S	151E	7882.36	9076.54	94.2849

latitude, we will use decimal degrees only. That greatly simplifies the calculations without significantly affecting the accuracy. There are 60 minutes in one degree of arc, and 60 seconds in one minute of arc. For our purposes, you can ignore seconds.

You'll need to convert minutes of arc to decimal parts of a degree for use in this program. One minute of arc equals .01667 degrees. For example, 16 degrees and 42 minutes would be 16.7 decimal degrees (you multiply 42 times .01667 to get 0.7). To convert the decimal part of a degree to minutes, divide the decimal by .01667.

When finished with its calculations, the program summarizes your input information, then quickly gives you the angles of each point from the North Pole, the nautical and statute miles between the two points, and the direction in degrees, measured clockwise from the North Pole.

The Program. The program (shown as Listing 1) was written in Microsoft GWBASIC for the IBM PC, which uses line numbers, and is essentially the same as IBM's BASICA. It will run fine in QuickBASIC or QBASIC, which do NOT need line numbers. For our purposes, the line numbers will make it easier to provide a line-by-line explanation of the program. Also, the varieties of BASIC for older microcomputers (TRS-80, Commodore, Apple, etc.) use line numbers.

The program is identified in lines 100–130. Line 140 sets the size of the A array to eleven elements, A(1) to A(11). These array elements will be used later as a convenient place to hold variables in a simple and organized fashion. Table 1 shows how each of the program variables is used.

Why did I use arrays? I originally wrote this program for a computer that only had 26 single-letter variables (A–Z), and it was convenient to use arrays as variables to keep some sense of order. When I translated the program to the IBM I retained this approach so that the most spartan BASIC variants could still accept and run the program.

Line 150 clears the screen and prints a blank screen line. Line 160 reminds you to place your keyboard in "caps-lock" mode, since some entries you make from the keyboard will not be recognized by the program if in lower-case. Lines 170–210 provide a program introduction, using the TAB statement to format the screen printing. Lines 220–240 contain remark statements that identify the spherical triangle angles and sides (as were shown back in Fig. 1).

Line 250 uses an INPUT statement to preserve the screen until you hit the ENTER key (actually, any key will do) to continue. Line 260 clears the screen and prints two blank screen lines. Line 270 reminds you again that you'll need to be in caps-lock mode to avoid lower-case character entries. Then lines 280–400 ask you for origin Point A and target Point B names and locations in longitude and latitude.

Line 410 clears the screen and prints two blank lines. Lines 420–570 summarize the information you've given the program about Points A and B and their relationship. Now the computer goes to work performing the calculations.

(Continued on page 94)

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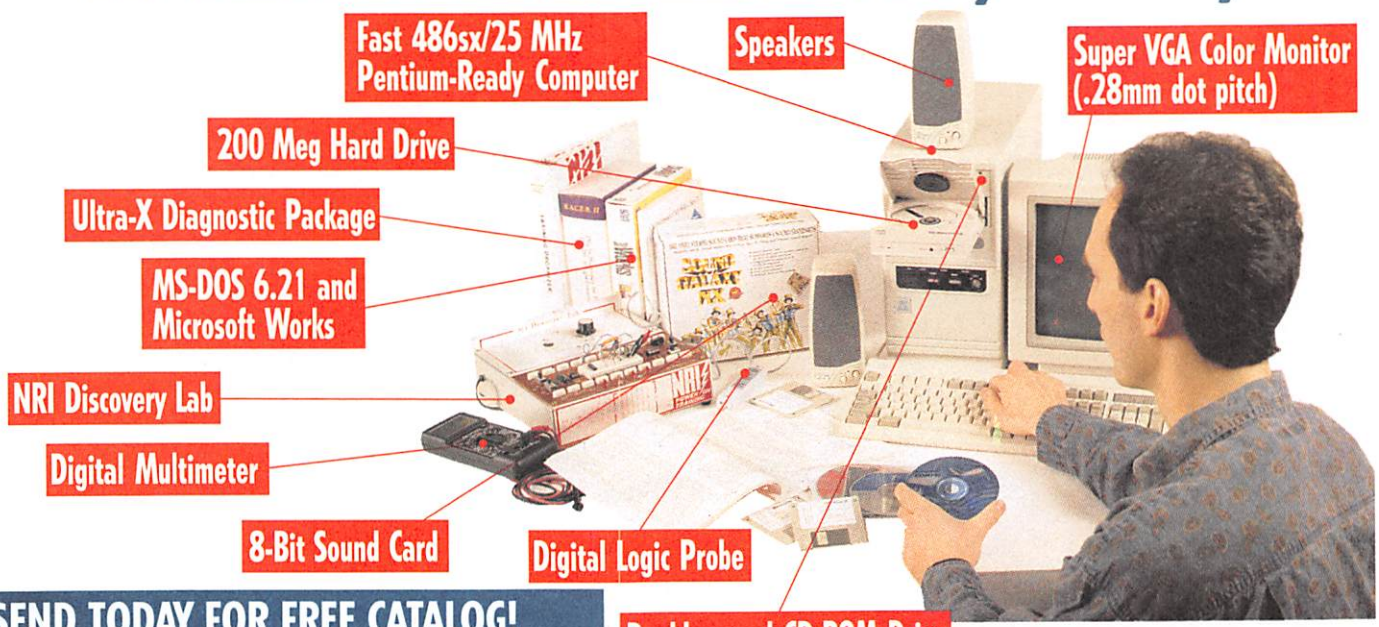

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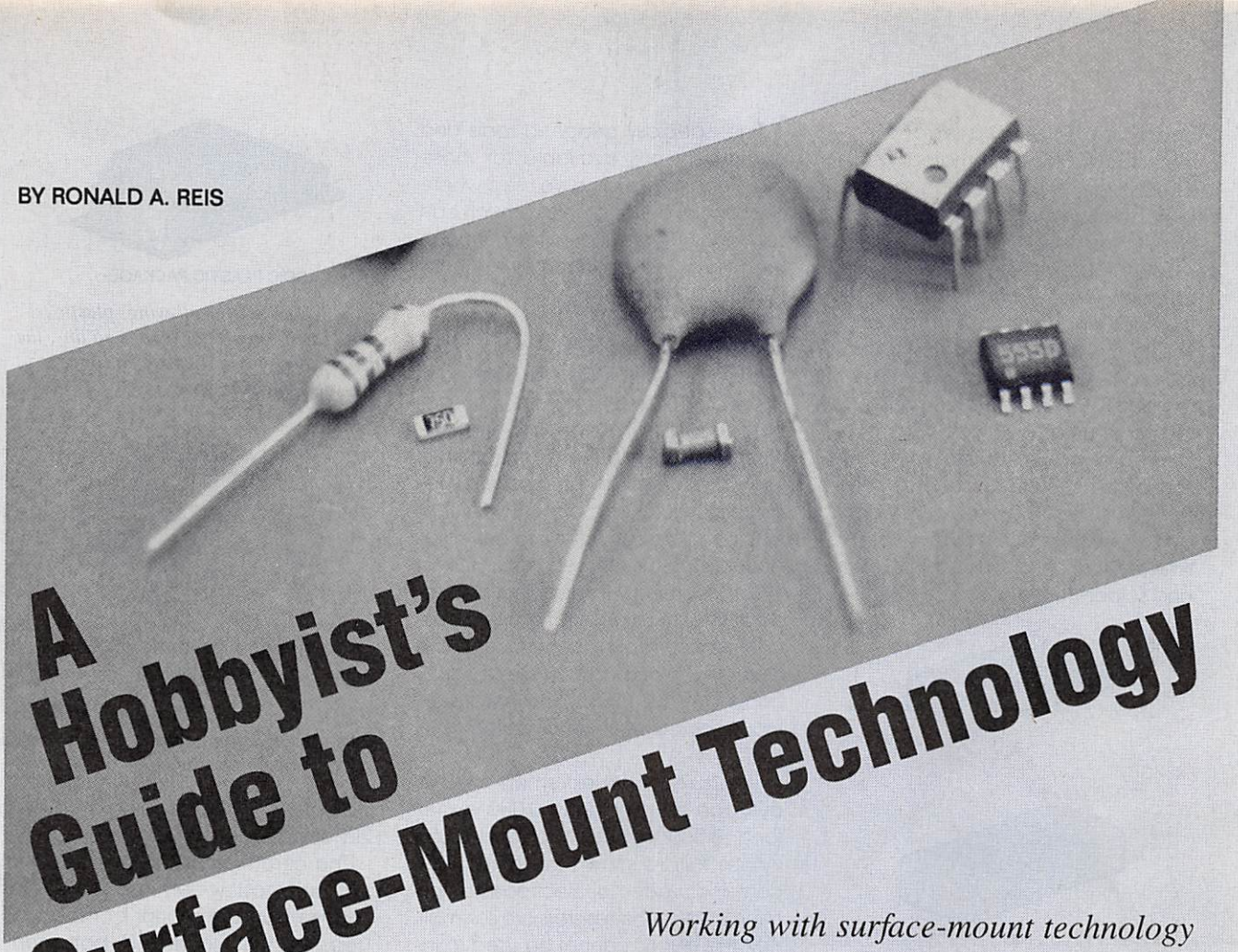

A Hobbyist's Guide to Surface-Mount Technology

Working with surface-mount technology is a lot easier than you might expect. Here are some tips for getting started with this innovative method of project building.

Looked inside the latest consumer electronic product lately? If you have, then chances are the printed-circuit board and components in your camcorder, pager, or CD player are not at all similar to what you have been building at your workbench. The leadless, discrete electronic components in these products have shrunk to the size of rice grains; the integrated circuits are often flea-size bugs with pins that are practically touching each other; and the printed-circuit board itself has no holes, except, perhaps, for mounting inside the case. Welcome to the fascinating, miniature world of surface-mount technology (SMT)—a world that sooner or later you, the electronics experimenter, will have to enter.

When looking at SMT-based consumer products, you might have wondered how it is possible to build a project using such tiny, surface-mount components (SMC's). At a glance, picking up SMC's, let alone soldering them in place, looks hard enough. Also, this basic question might come to mind: Are SMC's even available to experimenters?

Don't fret, and don't despair. Not only is it possible to build electronic projects using SMT, it can be accomplished easily, quickly, and, most importantly, with many of the traditional tools and materials probably sitting on your workbench. In addition, every month, electronics distributors are expanding their surface-mount component offerings. So, read on. Your days as a new kind of project builder might be just beginning.

The What and Why of SMT. Surface-mount technology is a packaging revolution that involves the attachment of tiny, essentially "leadless" components to pads on the printed or etched surface of a printed-circuit board—hence the name, "surface-mount technology." That contrasts with traditional "insertion-mount technology" (IMT) familiar to most hobbyists, which uses components with leads that are inserted through the PC board.

The SMT approach results in significant advantages, such as circuit board size and weight reduction, enhanced circuit performance and reliability, easier manufacturing, considerable cost reduction, and the development of entirely new products that would not be possible without the use of SMT. Consequently, it is estimated that by 1996, 70 to 80 percent of all electronic assemblies will be surface mount.

Can You Handle Them? The commercial assembly of SMT circuit boards is a fully automated process. Surface-mount components were designed from the beginning to be packaged in reel dispensers, put in place by X-Y pick-and-place machines, and soldered onto the PC

board using flow (wave) or reflow methods. In a fully automated SMT assembly line, no human hands ever touch the components or the printed-circuit boards.

Yet, throughout the life of an SMT product, rework is often required, and that does necessitate human intervention. Skilled electronics technicians often must manually remove or replace SMC's during initial assembly, testing, troubleshooting, or repair. Furthermore, project prototyping, the sort of thing electronics experimenters do all the time, is obviously done by hand, where one component at a time is positioned on the PC board and soldered into place.

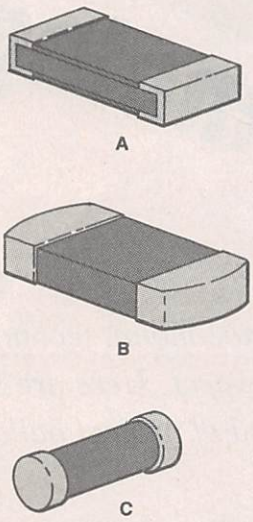

Fig. 1. Here are three discrete passive surface-mount components: (A) The leadless-chip resistor, (B) the similar-looking leadless-chip capacitor, and (C) the MELF leadless-cylinder diode.

True, specially designed tools and equipment are available for those tasks, and they should be used whenever possible. Nonetheless, much can be done with traditional tools, though they must be used in somewhat non-traditional ways.

Teeny, Tiny, SMC's. Several different types of SMC's are available. There are discrete passive components, such as resistors and capacitors; discrete active components, such as diodes and transistors; integrated circuits; and a few SMC's that do not fall into any of the other categories, such as trimmers and LED's.

Not surprisingly, the leadless chip resistor is the most popular discrete passive surface-mount component. It is available in standard values from 10 ohms to 10 megohms, and in wattage ratings as low as 1/16, and as high as 1/4, watt.

The resistors are extremely tiny, the average size being just 0.080 inches long, 0.050 inches wide, and 0.050 inches tall. As shown in Fig. 1A, they come with external electrodes or terminals. Since the resistors are so small, colored bands cannot be used to indicate their value. A simple three-digit system is used instead. The first two digits indicate the first two significant numbers of the resistance value; the third digit, the number of zeros.

For example, a code number 220 indicates a 22 ohm resistor. A code number 221 would designate a 220 ohm resistor. If the resistance value is less than 10 ohms, an "R" is used to indicate a decimal point. Therefore, 2R2 specifies a 2.2 ohm resistor.

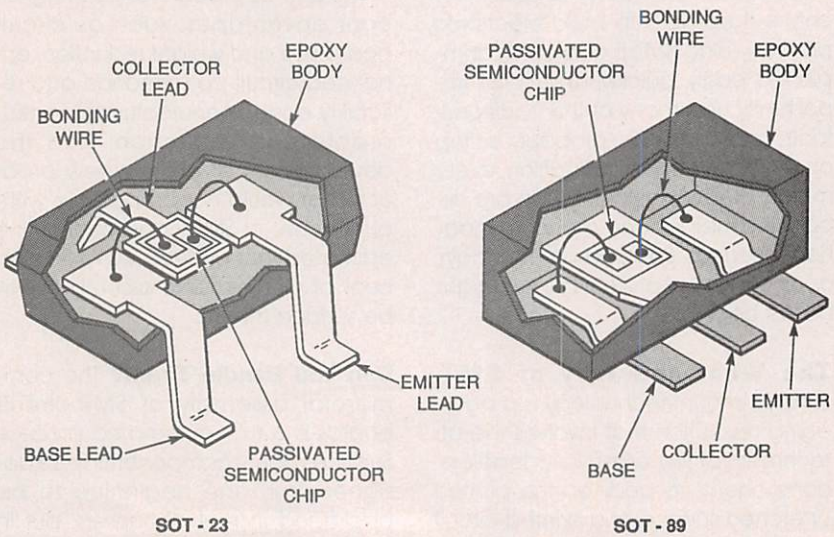

Fig. 2. The SOT-23 and SOT-89 are low- and high-power transistor packages, respectively. Note the difference in lead shape between these two discrete active SMC's.

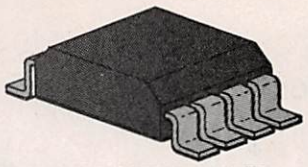

Fig. 3. The SOIC gull-wing, plastic integrated-circuit package is so tiny, the leads have only a 0.050-inch space between them.

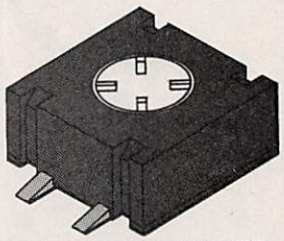

Fig. 4. Trimmer potentiometers and trimmer capacitors come in this type of surface-mount package.

The ceramic-chip capacitor is the second most widely used discrete, passive, surface-mount component (see Fig. 1B). It comes in both non-polarized and polarized versions. The former range in value from 1 pF to 1 µF; the latter (most often tantalums) are available from 0.1 µF to 100 µF. Voltage ratings go as high as 1000 volts.

Surface-mount capacitors look a lot like SMC resistors. They are the same size (some tantalums are larger) and the terminals are almost identical. There is one major difference in appearance, however. In most cases, no value designation is printed on the capacitor—there is no room. Instead, the thin cardboard backing that runs the length of a strip of packaged capacitors has a value printed on it about every inch, or so.

Turning to discrete active SMC's, the two-terminal diode in an MELF (metal-electrode face) leadless cylinder is popular. The package, shown in Fig. 1C, is also known as an SOD, for small-outline diode, and is but 1/10 of an inch in diameter and 1/5 of an inch long.

Low-power transistors come in SOT-23 (small-outline transistor) packages, as shown in Fig. 2. The devices are only 0.118 inches long, 0.05 inches wide, and 0.04 inches tall. Note the gull-wing lead configuration. With that shape it is much easier to solder

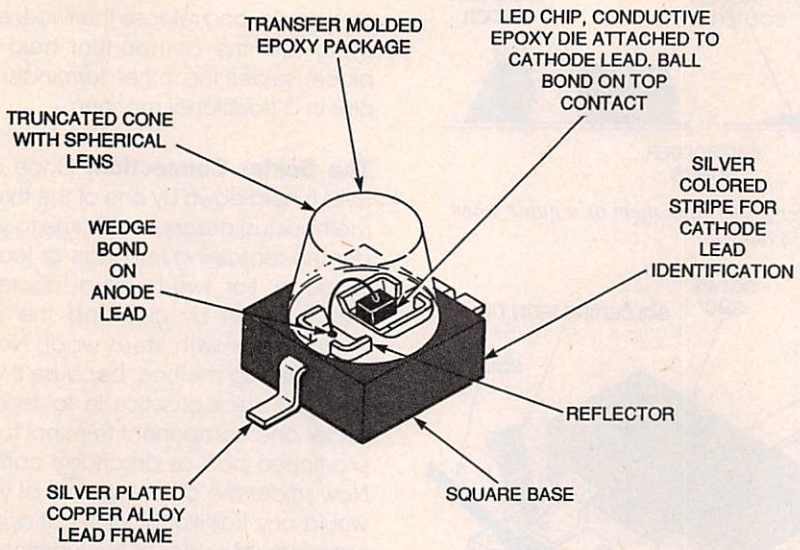

Fig. 5. Subminiature surface-mount LED's, like this one, are useful in a wide variety of applications, due to their high reflection efficiency.

the leads, as you will discover shortly. Transistors required to dissipate more power than the general-purpose type are available in an SOT-89 package, also shown in Fig. 2.

Surface-mount integrated circuits are available in a number of packages with a variety of lead configurations. The type most likely to be encountered by the electronics experimenter, however, is the small outline integrated circuit (SOIC) shown in Fig. 3. Note, again, the gull-wing lead configuration. While SOIC's look like miniature DIP's (traditional through-hole IC's), they are barely ¼ the size of their larger cousins. Furthermore, their lead spacing is only 0.050 inches, half that of the traditional DIP.

Many other electronic components, in addition to the ones discussed above, come in surface-mount configurations. While all can not possibly be discussed here, two deserve particular note. Trimmer potentiometers and trimmer capacitors come in the type of package seen in Fig. 4, and are quite common. Typical potentiometer values range from 100 ohms to 2 megohms. Trimmer capacitors are found in values from 1.4 pF to 50 pF.

Subminiature surface-mount LED's, of the type shown in Fig. 5, are now finding wide application in electronic circuits. Due to their high reflection efficiency, the brightness of these LED's does not decrease with size. Note, once more, the popular gull-wing lead configuration.

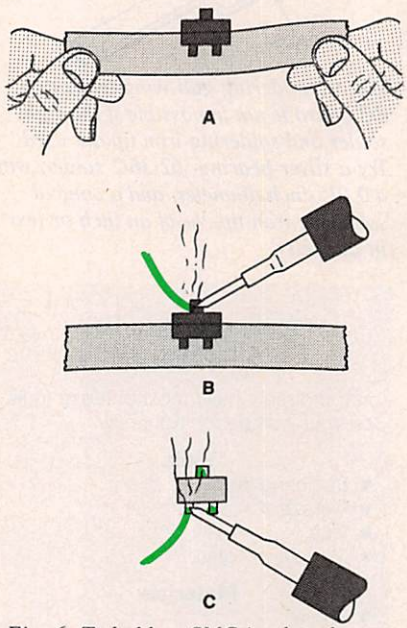

Fig. 6. To hold an SMC in place by taping, (A) begin by touching the tape to the SMC. (B) After taping the component to the PC board, solder the exposed terminal(s). (C) Finally, remove the tape and then solder the remaining terminal(s) to their pads.

Tools and Materials. Below, you will find three methods used to hold SMC's in place while hand-soldering with solder wire. Since you will undoubtedly be experimenting with all three approaches, you should obtain all of the tools and materials listed in the Tools and Materials box.

For SMT work, the soldering iron needs to be from 25 to 40 watts and have a tinned tip with a conical shape, 1/16 of an inch or less in diameter. A tweezers is mandatory for picking up tiny SMC's. It should have forceps-style tips. A vise is a must for securing the PC board while components are being attached. Smooth-jaw type vises work well. If you don't have a desk-top magnifying glass, you should consider purchasing one. At the very least, an inexpensive hand-held one should be used.

As for the materials listed in the box, they are fairly self-explanatory. Solder should be 63/37 (tin/lead) or, better yet, silver-bearing solder at 62/36/2 (tin/lead/silver). A diameter of 0.020 inches works well, but 0.015 inches is better. A noncorrosive liquid flux and drop dispenser are necessary. So is a light-duty spray defluxer. A general-purpose plastic cement, the kind used for plastic, wood, or metal, is fine. When choosing solder wick, select a diameter of 0.030 inches. Finally, ordinary clear tape, ½ an inch in diameter, will work well. Any other materials that you might need are probably lying around your house.

Putting SMC's in Their Place. There are three easy ways to hold SMC's down in preparation for soldering them permanently in place. You can tape, stick, or tag them to the PC board.

To temporarily hold an SMC in place by taping, begin by simply grasping a short strip of clear tape and "touching" it to the SMC, picking up the latter. See Fig. 6A. You then tape the SMC onto its PC board pads. With the component held securely in place by the tape, solder the exposed terminal(s) (Fig. 6B). Remove the tape, then solder the remaining terminal(s) to their pads (Fig. 6C).

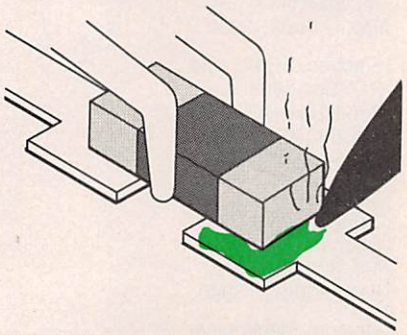

Fig. 7. To tag solder an SMC in place, create a pool of solder on a pad, place the component above it, and reheat the solder so the SMC can "sink" close to the board surface.

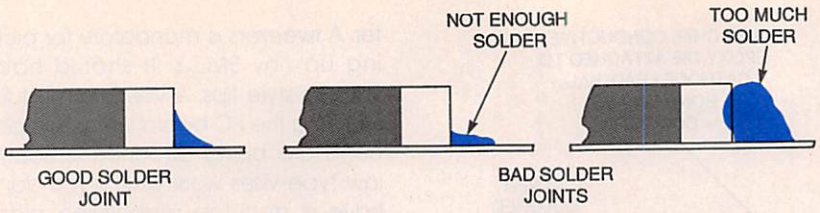

Fig. 8. Here are examples of good and bad solder joints. Use them as a guide when soldering to make sure your connections are good ones.

Another way to hold an SMC to the circuit board in preparation for final soldering is to glue it in place. A general-purpose glue (that comes in a jar), such as the General Purpose Plastic Cement, 10-324, from GC Electronics, works well.

When working with the glue, the best way to dispense the material is with a toothpick. Dip the pick into the liquid so it just touches the surface. Then place a dot of glue on the PC board, being careful not to get any of it on the copper pads. Gently press the component into place and let the glue dry for about 30 minutes. Be careful not to apply too much glue; remember, its purpose is only to secure the SMC for soldering. The rule is: "A little dab'll do you."

Even though I often use the tape and stick methods just described, I prefer the tag soldering approach. It's easy, quick, and involves no additional materials such as tape or adhesives. All you need are tweezers, and the solder wire and soldering iron that you would use anyway.

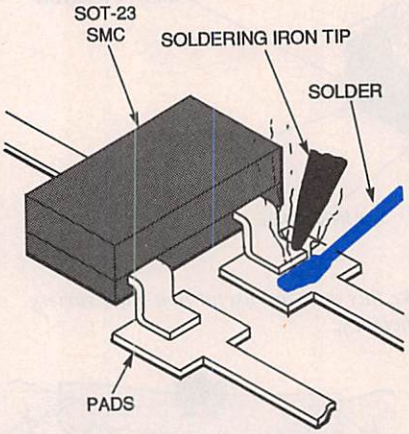

Fig. 9. Soldering gull-wing leads to a PC board is not impossible if the right solder and soldering iron tip are used. Try a silver-bearing, 62/36/2 solder, with a 0.015-inch diameter, and a conical soldering iron tip, 1/16 of an inch or less in diameter.

SMC Distributors

Here is a sampling of electronics distributors that carry a wide selection of SMC's.

Digi-Key Corp.
701 Brooks Ave. South
Thief River Falls, MN 56701-0677
Tel. 800-344-4539
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Electronic Goldmine
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FAX: 818-998-7975

Tools and Materials For Attaching SMC's

You probably have most of these tools on your workbench right now.

Tools

- Soldering iron
- Tweezers
- Vise
- Magnifying glass

Materials

- Solder
- Liquid flux
- Drop dispenser
- Defluxer
- Adhesive
- Solder wick
- Clear tape

First, apply a dab of liquid flux to one PC board pad. Then create a pool of solder on that pad. Allow the solder to solidify.

Next, with the SMC held in a tweezers, rest the component on its PC board pads and hold it in place. Using a soldering iron held in your other hand, reflow the solder, causing the component terminal to "sink" close to the board surface. See Fig. 7. Remove the iron, allow the solder to cool again, and release the tweezers. Then, with the component held in place, solder the other terminals or pins in a traditional manner.

The Solder Connection. Once an SMC is held down by one of the three methods just described, it's time to solder the remaining terminals or leads in place. For two-terminal discrete SMC's, begin by cleaning the PC board pads with steel wool. Next, using the tag method, because it will give you quick practice in soldering, solder one component terminal to its pre-tinned pad as described earlier. Now solder the other terminal as you would any traditional joint, but apply just a dab of solder at the junction of the iron tip and component terminal. See Fig. 8 for examples of good and bad solder joints.

To solder gull-wing leads on three- and four-lead components, proceed as above, only be sure to apply plenty of liquid flux before you actually solder. Doing so makes for a much more effective solder connection. See Fig. 9.

Hand soldering DIP gull-wing SOIC's to a circuit board is not difficult. Just follow these ten steps:

1. Make sure all pads are clean and ready for soldering.
2. Create a pool of solder on a corner pad in preparation for tag soldering.
3. Hold the IC with a tweezers.
4. Place the IC onto the copper pads. Be sure to center the IC right-to-left as well as top-to-bottom. Hold the IC in place.
5. Apply the soldering iron tip to the pre-tinned pad. Hold the iron in place just long enough to flow the solder.
6. Pivot the IC about the soldered pin as necessary to again align all pins with their respective pads.
7. Solder a second pin in the opposite corner to the first. In doing so, don't forget to apply a small amount of liquid flux.
8. Bathe one line of pins with liquid flux.
9. Solder the line of pins, one at a time. Move quickly, yet adhere to the four traditional soldering steps: apply heat, apply solder, remove solder, and remove heat. Apply liquid flux to the opposite row of pins and solder as just described.

(Continued on page 91)

Build A WWV Receiver

Get time, weather, frequency, and other information with this easy-to-build receiver.

BY BRIAN MCKEAN

Next to the crystal detector and super-regenerative receivers, the direct-conversion receiver is the simplest radio that any experimenter can build. Despite its being immune to spurious IF signals, which plague super-heterodyne receivers, the direct-conversion receiver has been shunned in the past because of component limitations that make first-try receivers sensitive to 60-Hz hum, microphonics, and low-frequency noise generated by active components. But ever-evolving electronics technology has produced low-noise/low-power amplifiers and mechanically stable components that promise to revive the direct-conversion receiver. Low-power active elements allow battery operation, significantly improving 60-Hz suppression.

The *WWV Receiver* described in this article (which contains only one tuned circuit) is comprised of readily available parts and its operating frequency can be easily modified, allowing you to monitor other signals.

WWV/WWVH Broadcasts. Radio stations WWV (Fort Collins, CO) and WWVH (Kauai, HI), operated by the National Institute of Standards and Technology (NIST), broadcast vast amounts of information 24 hours a day. The most obvious are the frequency standards of the carrier (2.5, 5, 10, 15, and 20 MHz), the 1-second time interval, and the standard audio tones (440, 500, and 600 Hz), which modulate the carrier at regular intervals.

Voice announcements, broadcast at one-minute intervals, give the time of day based on a cesium clock and expressed in "Coordinated Universal Time" (UTC). The radio stations are identified by voice on the half hour and the hour, and continuously via audio tones. WWV transmits 500 Hz on even minutes while WWVH transmits 600 Hz on even minutes. The 5-, 10-, and 15-MHz carriers operate at 10 kW, making them easily audible throughout the continental US.

Special voice announcements, providing Global Positioning Satellite status, Geophysical data, OMEGA navigation system status, and Pacific and Atlantic storm warnings, are broadcast in regular time slots. UTC to UT1 conversion information is also broadcast.

Those stations also broadcast the time of day, day of year, year, daylight saving's time status, leap second status, and UTC to UT1 conversion in a digital format. The digital code is transmitted at a rate of 1-bit-per-second on a 100-Hz subcarrier that is pulsed on and off, with the duration of the pulse representing the bit value "1" or "0" at the beginning of each second. The 100-Hz subcarrier is typically below the bandwidth provided by commercial shortwave receivers, so the pulses are not audible.

The direct conversion receiver does not have a high cutoff frequency on the HPF, so the 100-Hz pulses will be clearly audible on the direct-conversion receiver described in this article. Although intended for digital decoding, the low bit rate allows the BCD code to be decoded by ear with a little practice and a strong signal.

The most useful data transmitted by the NIST stations are the frequency standards. Those carriers allow worldwide frequency calibration to an accuracy of 1 ppm. The direct conversion receiver can serve in a secondary capacity as a 10-MHz, local-frequency standard since the local oscillator must be zero beat for best reception. The voltage-stabilized crystal oscillator will allow the receiver to maintain its calibration under varying conditions.

Shortwave listeners will find the geophysical alert messages useful in correlating radio propagation conditions with solar activity and geomagnetic field disturbances. The NIST signals themselves provide direct information on band conditions. Poor reception in an otherwise good local-reception time period is usually indicative of some geophysical disturbance, which will be noted in the alert message. The geophysical bulletins (18 minutes after the hour for WWV and 45 minutes after the hour for WWVH) provide a daily summary of past 24-hour's solar and geomagnetic-field activity with 3-hour updates of current geomagnetic field conditions.

The solar-flux measurement is a measure of the solar emission at 2800 MHz, and is related to the solar constant, which is a measure of the total solar flux at the Earth. Solar flux is responsible for ionizing the upper atmosphere and, as such, affects long-distance high-frequency communications, which rely on ionosphere propagation modes.

The "A" and "K" indices in the message provide information on geomagnetic-field activity. The "K" index is measured at 3-hour intervals, and the "A" index is derived by taking the weighted average of the K index for a 24 hour period. From 0 UT to 2100 UT, the "A" index represents the previous day's measure. Between 2100 and 2400 UT, the "A" index is estimated from the 7 "K" indices for that day. The "A" index is finally produced at 2400 UT and remains unchanged until 2100 the following day.

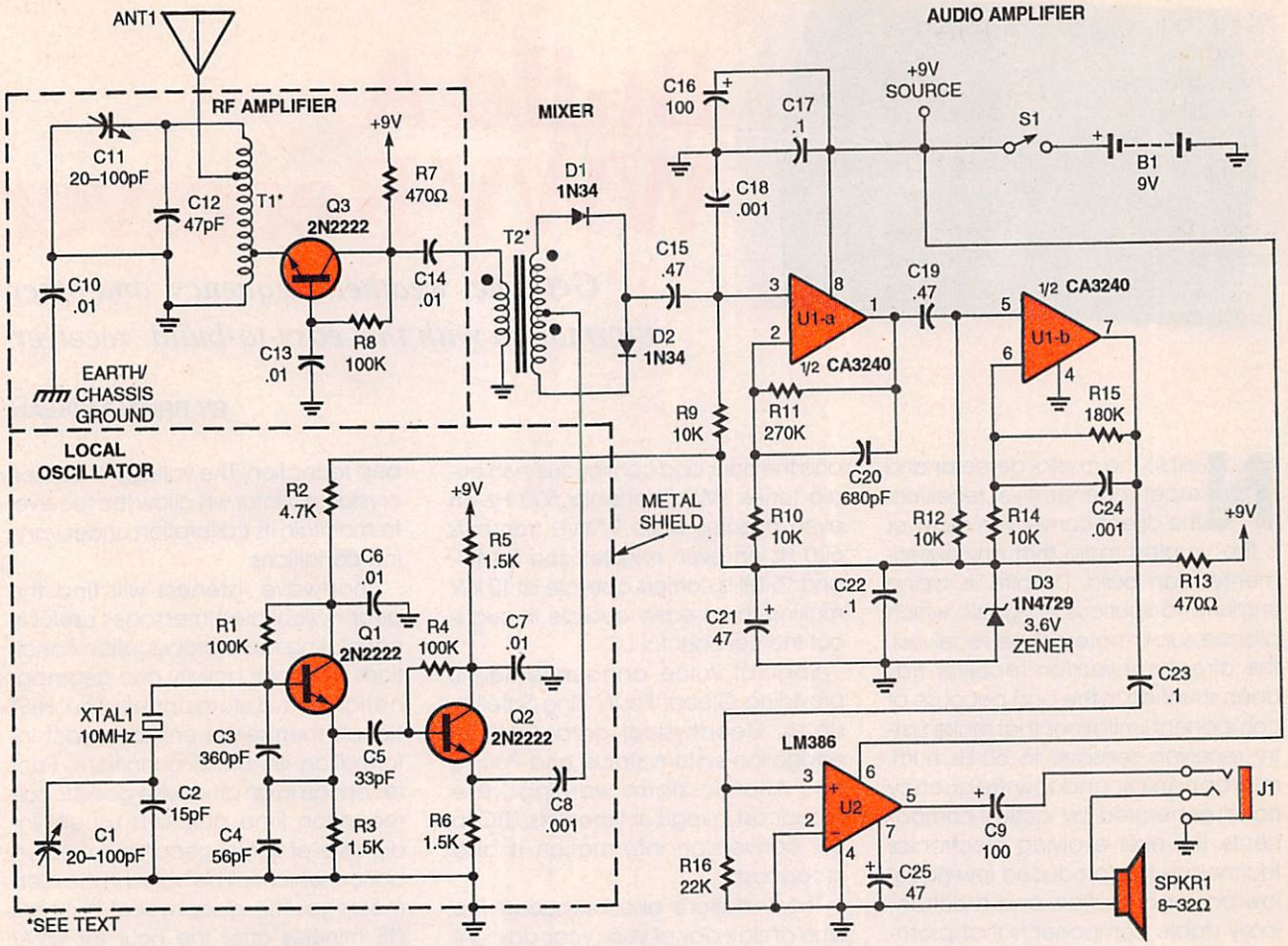


Fig. 1. The single balanced-diode mixer used in the WWV Receiver includes a transformer to phase shift the RF input, while a pair of oppositely oriented diodes are used to phase shift the LO signal. The LO amplitude must be sufficient to forward bias the diodes.

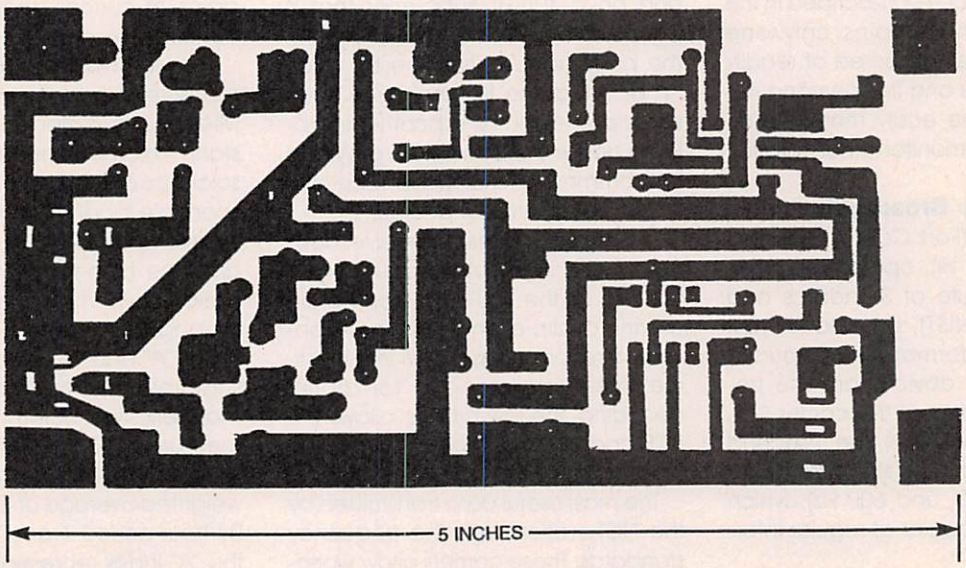


Fig. 2. The author's prototype was assembled on a small printed-circuit board, measuring about 5 by 2½ inches, and is shown here on a 1:1 scale.

Geomagnetic-field activity is described in broad terms such as "quiet," "unsettled," "minor storm," etc., which are selected based on the current "K" and "A" indices. Solar activity describes the solar-flare activity by measurements of peak X-ray emissions from a flare event.

Note: Further information regarding

NIST broadcasts can be obtained by writing to: National Institute of Standards and Technology, Radio Station WWV, 2000 East County Road, Fort Collins, CO 80524. Ask for NIST publication SP 432.

Circuit Detail. Figure 1 shows a schematic diagram of the WWV Receiver. Incoming RF is picked by the antenna (ANT1) and is coupled via an autotransformer to a grounded-base amplifier (Q3), before being applied to a diode-mixer network that is comprised of T2, D1, and, D2. Best mixer performance is obtained when both secondary windings of T2 are identical, and D1 and D2 are matched.

The output of the local oscillator (LO)—a grounded-collector Colpitts oscillator (built around Q1)—is applied to emitter-follower/buffer Q2, which provides a low impedance drive signal for the mixer.

The demodulated signal is capacitively coupled, through high-pass RC networks to a pair of high gain op-amp stages (U1-a and U1-b). The op-amps provide a 50-dB gain and incorporate low-pass filter capacitors in the feedback path. Amplifier U2 provides a 20-dB gain, thereby producing sufficient output drive for an 8-ohm speaker, or 32-ohm headphones.

Note that our receiver lacks a volume control and AGC circuitry. That simplifies the circuit without introducing operational problems. The volume is controlled merely by adjusting the length of the whip antenna.

When driving 32-ohm headphones, the circuit consumes less than 25 mA; however, the current drain increases to 40 mA when driving an 8-ohm speaker. That current drain is close to the limit of 9-volt alkaline batteries, so headphone operation is preferred, especially under weak-signal conditions.

Assembly. The WWV Receiver was assembled on a printed-circuit board, measuring about 5 by 2½ inches. A template of the author's printed-circuit layout is shown in Fig. 2. The parts-placement diagram for the author's layout is shown in Fig. 3. All the parts except power switch S1, battery B1, speaker SPKR1, and antenna ANT1 are located on the board.

The crystal can be any of a number

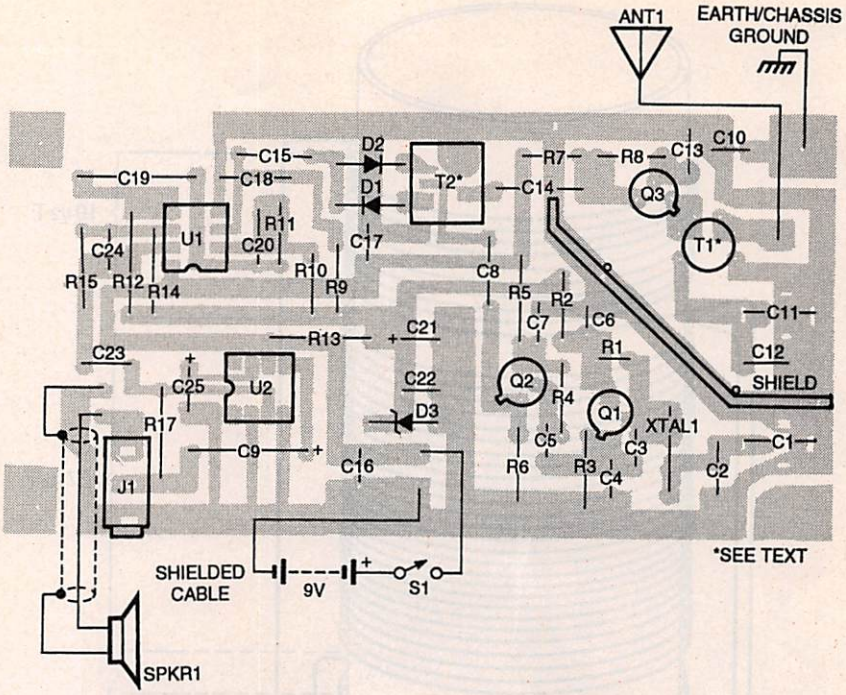


Fig. 3. All the parts that comprise the WWV Receiver (except the battery, the power switch, the antenna, and the headphone jack) are mounted directly to the circuit board. A metal shield (see text for details) is added to the board at the position shown to isolate the RF input section from the local oscillator.

PARTS LIST FOR THE WWV RECEIVER

SEMICONDUCTORS

U1—CA3240, HA3-5152, HA7-5222, or similar, dual op-amp, integrated circuit
U2—LM386 low-voltage, audio-power amplifier, integrated circuit
Q1–Q3—2N2222, 2N3904, or similar general-purpose NPN silicon transistor
D1, D2—1N34 germanium or NTE112 Schottky, small-signal diode
D3—1N4729, or similar 3.6-volt, 1-watt Zener diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R4, R8—100,000-ohm
R2—4700-ohm
R3, R5, R6—1500-ohm
R7, R13—470-ohm
R9, R10, R12, R14—10,000-ohm
R11—270,000-ohm
R15—180,000-ohm
R16—22,000-ohm

CAPACITORS

C1, C11—20- to 100-pF ceramic or mica trimmer (Mouser 242-3610-100 or equivalent)
C2—15-pF mica or ceramic-disc
C3—360-pF mica or ceramic-disc
C4—56-pF mica or ceramic-disc
C5—33-pF mica or ceramic-disc
C6, C7, C10, C13, C14—0.01-μF, ceramic-disc
C8, C18, C24—0.001-μF, ceramic-disc
C9, C16—100-μF, 16-WVDC, electrolytic
C12—47-pF mica or ceramic-disc
C15, C19—0.47-μF, polystyrene, mylar, or multilayer ceramic
C17, C22, C23—0.1-μF, ceramic disc
C20—680-pF mica or ceramic disc
C21, C25—47-μF, 10-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

ANT1—50- to 100-cm telescoping antenna
J1—Closed circuit ⅛-inch headphone jack
SPKR1—8- to 32-ohm, 0.5-watt or less, speaker
S1—SPST power switch
B1—9-volt alkaline, transistor-radio battery
T1, T2—See text
XTAL1—10-MHz, 30-pF crystal
Printed-circuit materials, metal enclosure, metal shield material (see text), headphone (32 ohm), battery holder and connector, wire, solder, hardware, etc.

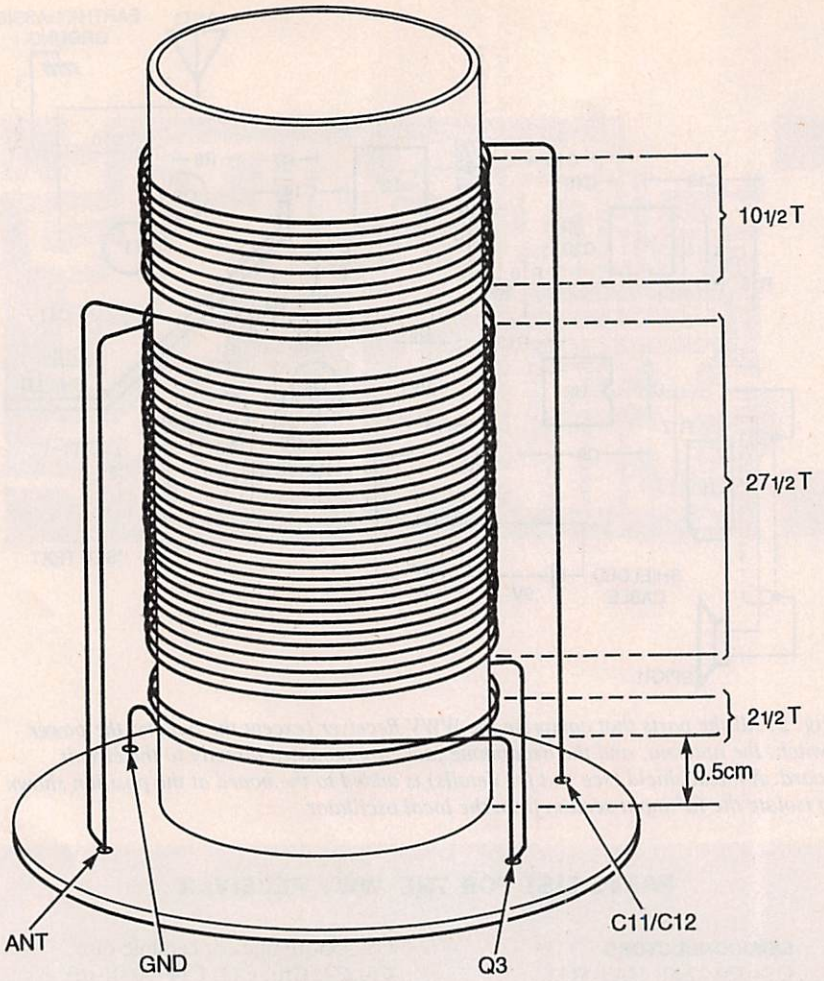


Fig. 4. Transformer T1 is a home-made unit comprised of 40 closely wound turns of #26 AWG enameled wire on a ¼-inch diameter air-core form, with taps at 2½ and 10½ turns from each end; after each tap, the winding continues in the same direction.

of physical sizes (note that the board layout is designed to accommodate the most common crystal-package sizes; the HC-49 and HC-33). To minimize microphonics—the generation of an electrical noise signal by mechanical motion (vibration) of parts within a device—after soldering XTAL1 in place, secure it to the board with RTV or similar silicone cement.

Tuning capacitors C1 and C11 should be installed with the tuning screw connected to ground to allow use of a metal tuning tool. The holes for T1 are arranged for use with a ¼-inch diameter, plastic coil form with a molded base of the type commonly found in older TV sets. The holes for T2 are sized for a common subminiature IF can. The leads of T2 should be cut as short as possible and secured to minimize vibration.

Install a solderable-foil metal shield (approximately 1-inch high) between the local oscillator (Q1 and Q2) and RF amplifier (Q3), as shown in Fig. 3. Solder the shield to the ground trace using short segments of stiff wire as supports. Once all of the board-mounted components have been installed, connect the off-board components to the printed-circuit board though short lengths of hook-up wire.

Mount the whip antenna on the proposed case for the unit; if the antenna that you choose for your unit has a pivoting base, the unit can be mounted in just about any convenient location on the enclosure using a low capacitance mounting method; or you can connect the antenna (vertically mounted) directly to the board. Many whip antennas are equipped with a threaded base that can be secured directly to the appropriate printed-circuit pads using a screw. If that arrangement is used, use a large grommet to isolate the whip from the metal case where the antenna passes through.

Component Notes. The crystal is used in its parallel (anti-resonant) mode in the Colpitts oscillator. Parallel-mode crystals are specified for a particular circuit load-capacitance—usually 20 to 40 pF—for the crystal to oscillate on frequency. Capacitors C1 and C2 provide series coupling to reduce the relatively large load capacitance of Q1 and

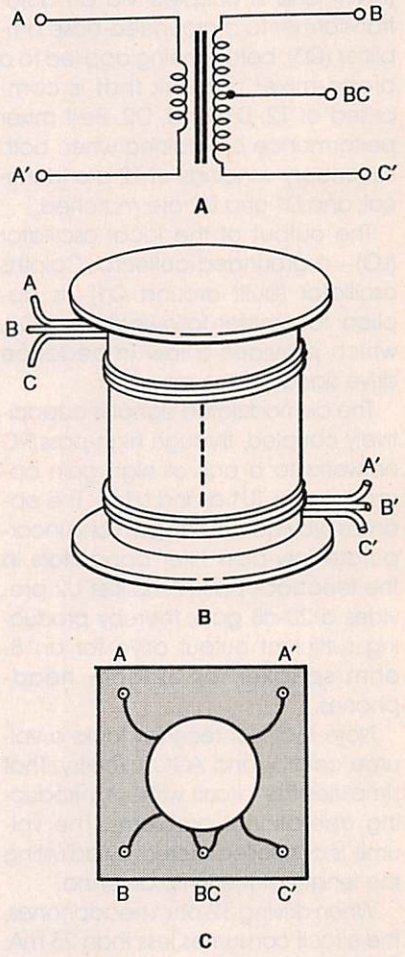
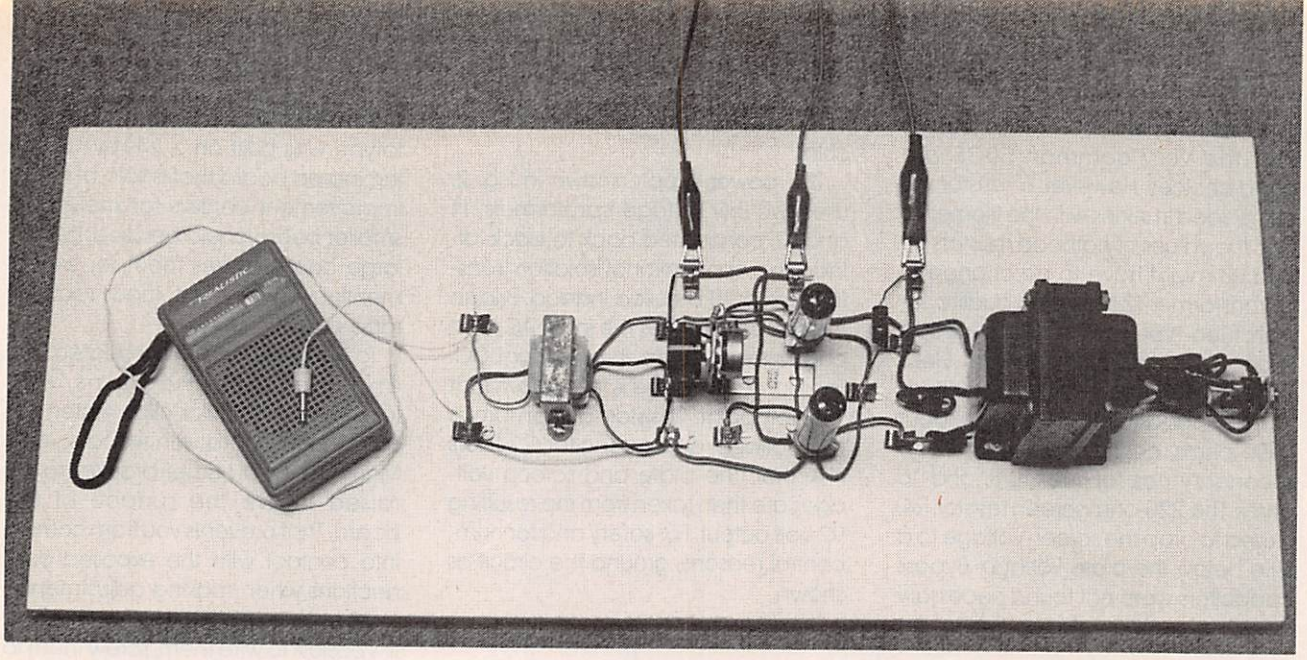


Fig. 5. Construction details for T2 (the mixer transformer) are shown here. The diagram in A is a schematic representation of the unit once completed; B illustrates how the three lengths of wire are wound as a set on the bobbin; and C shows how the bobbin is connected to the pinned base.

allow tuning the crystal frequency. The trimmer range specified for C1 should satisfy most crystals. If you have no information about your crystal, try it anyway. The oscillator's operation can be checked by any number of methods, but the easiest way is to listen to the receiver itself.

The mixer diodes should be small-

(Continued on page 93)



Build a Vacuum-Tube Audio Amplifier

Build this audio amplifier and hear the difference tubes make in sound, without making a big difference in your wallet.

BY LARRY LISLE

Vacuum tubes seem to have a glowing future in expensive, high-end audio equipment. How come? What makes people shell out good money for amplifiers using devices that most thought were obsolete years ago?

Those who like them say that tubes sound better. They use words like "mellow" and "warm" to describe the tube sound. On the other hand, there are also those who don't like tube audio, or say that there's no difference in the sound at all.

How do you tell if *you* like the sound of tubes without making a big investment? Build the super-simple amplifier described below and hear what tube sound is like at a reasonable cost. That way, you can get some experience working with tubes while building a nice little amp you'll be proud to own.

Circuit Description. The circuit shown in Fig. 1 is the classic push-pull tube amplifier used for generations. That amplifier is flat within ±1 dB from 20 to 20,000 Hz into a resistive load, and is deceptively uncomplicated considering its performance. As explained below, the amplifier's design prevents hum and unwanted feedback—two of the toughest problems in the home construction of tube-audio systems.

Hum is minimized in two ways: First, a nickel-core input transformer, T1 (available from Antique Electronic Supply, 6221 S. Maple Avenue, Tempe, AZ 85283, Tel. 602-820-5411; FAX: 602-820-4643) is used. Then, any remaining hum can be further reduced by balancing the two sides of the circuit via R1, located in the cathode circuit.

Unwanted feedback is avoided because the circuit is designed as a single-stage amplifier. The sensitivity of the 60FX5 vacuum tubes, V1 and V2, makes that possible.

The amplifier can be driven to full output with less than 3 volts of audio input on the grids, making it ideal for use with a battery-operated radio or tape player. At about 3 watts, the output of the amp is adequate for quiet listening on a 15-inch speaker, and is great for earphones. Of course, the tubes can be pushed slightly beyond the linear portion of their operating curve (overdriven) to give a kind of distortion that some "tube-philes" like; more on that later.

The amplifier operates on a 120-volt power supply. That is low for tubes and was selected for safety reasons. The "60" in the designation of the 60FX5's indicates the filament voltage. Connecting the filaments of the two tubes in series permits them to be wired directly across the 120-volt DC output of the power supply. The filaments of audio tubes should be operated with DC whenever possible.

The 60FX5 is a sensitive, inexpensive tube (currently selling for under $3) that works well in the circuit, but other tubes could also be used without changing the socket connections. If you want to substitute tubes with 50-

volt filaments, the 50FK5, the 50EH5, and the very common 50C5 are good choices. However, a resistor will be needed in series with the filaments, and the values of cathode resistors R2 and R3 might have to be changed.

Transformer T2 is a good quality, 10-watt, tube-type audio-output unit that is also available from Antique Electronic Supply (as model PT-1608). Its primary has an impedance of about 8000 ohms, center tapped, and the secondary has taps for 4, 8, and 16 ohms. The 220-ohm screen resistor, R4, is used to drop the screen voltage to a little below the plate voltage. Bypass capacitors were not found necessary in either the cathode or screen circuits.

The power supply, shown in Fig. 2, uses two low-voltage transformers, T1 and T2, connected back-to-back, although a conventional isolation transformer could be used instead. Bridge rectifier BR1 rectifies the input AC, and capacitor C1 filters the resultant DC. The filament voltage is taken from that 120-volt point. Resistor R1 then drops that voltage, and capacitor C2 filters it further. The plate and screen voltages are then taken from the resulting 92-volt output. For safety and for hum-control reasons, ground the circuit as shown.

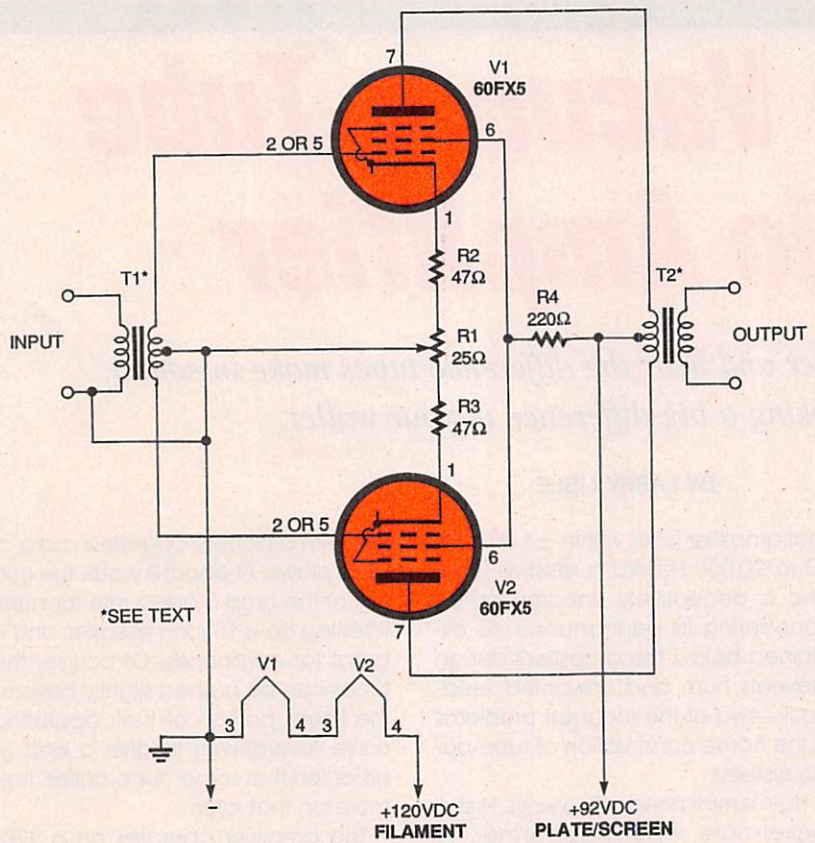


Fig. 1. Here is the schematic for the tube amplifier. Its single-stage design, which eliminates unwanted feedback, was made possible by the sensitive 60FX5 vacuum tubes.

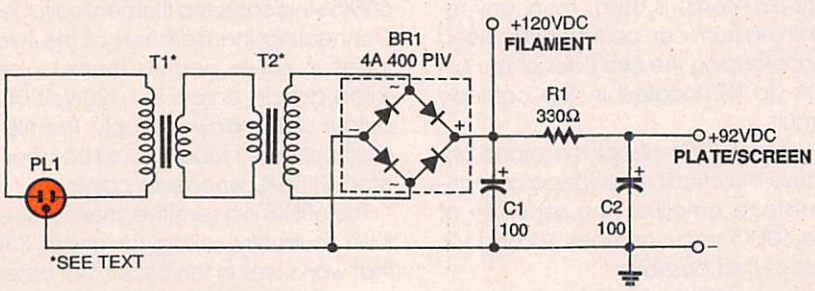


Fig. 2. The power supply for the amplifier uses two low-voltage transformers connected back-to-back. The full-wave bridge rectifier, BR1, provides DC for the filaments, plates, and screens.

Construction. The amplifier prototype was built on a 24- by 10-inch laminated board that is sold at home improvement centers for shelving. A smaller board could be used, but the large one provides room for experimenting and for the input radio or tape player.

To wire the circuit, use insulated wire and make connections with fahnestock or similar clips; fasten the clips to the board with wood screws. Mount R1 on a corner bracket so it is raised above the surface of the board. That prevents you from coming into contact with the exposed connections when making adjustments.

When connecting the tube sockets, it is easiest to wire them, screw them to the board, and then trim the wires to an appropriate length. As for the leads of T1 and T2, don't trim them too short—you might want to use the transformers in other projects. The audio output from T2 can either be wired to fahnestock clips, or connected to an audio jack, depending on the nature of your speaker's leads.

The power-supply prototype was built on a separate 9- by 4-inch pine board so it could be physically separated from the amplifier. That is a good practice in audio work because hum might be radiated by the magnetic fields of the transformers and

PARTS LIST FOR THE TUBE AMPLIFIER

RESISTORS

(All fixed resistors are 5% units.)
R1—25-ohm, 2-watt, potentiometer
R2, R3—47-ohm, ½-watt
R4—220-ohm, 1-watt

ADDITIONAL PARTS AND MATERIALS

T1—Tube interstage transformer, 1:1 to 1:3 turn ratio, Antique Electronic Supply PT-157 or equivalent
T2—Tube-type audio-output transformer, Antique Electronic Supply PT-1608 or equivalent (see text)
V1, V2—60FX5 vacuum tube
24- by 10-inch baseboard, corner bracket, knob for variable resistor, two 7-pin miniature tube sockets, fahnestock clips, audio-output jack (optional), speaker or headphones, alligator clips, screws, insulated wire, solder, hardware, etc.

hash (RF noise) might be given off by the rectifier.

Like the amplifier, you can wire the power supply using insulated wire and fahnestock clips. A small terminal strip can be used to mount BR1. To prevent strain on T1 and T2, use a couple of cable clamps on the power cord.

If you're new to tube voltages, be careful! **Do not touch any part of the amplifier except the knob of R1 while the power supply is plugged in.** After unplugging the amplifier, short the two positive-output fahnestock clips on the power supply to the negative clip to make sure the capacitors have discharged. If the amplifier and power supply are to be placed in regular service where others might come in contact with them, they should be enclosed. Exposed high voltages are not the only danger present—tubes get hot!

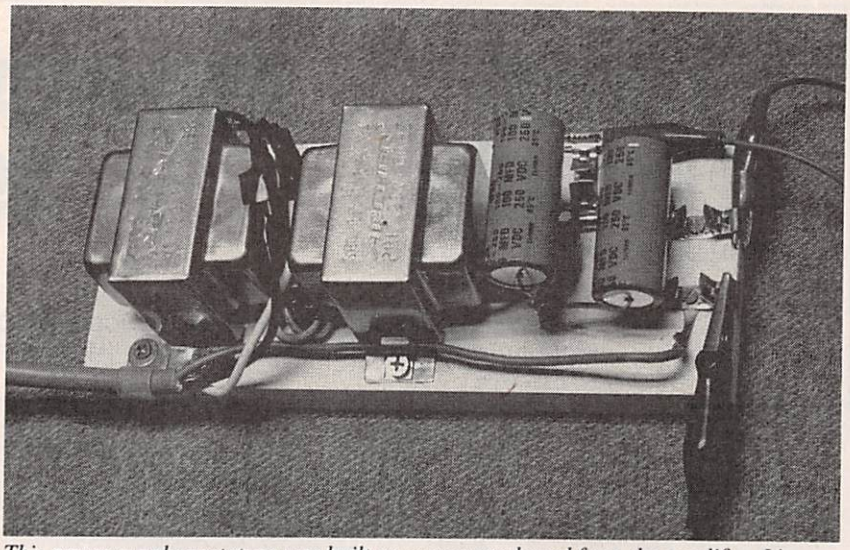
Checkout and Use. Double-check all wiring to make sure it is correct. Then, make the following connections between the amplifier and power-supply using insulated wires that have insulated alligator clips on both ends.

Begin with the power supply *unplugged*. Temporarily connect the plate/screen lead clip from the amplifier to the filament clip on the power supply. Properly connect the negative ground lead to the power supply. Then, short the input of the amplifier with a piece of wire, and connect a speaker to the output of T2.

Plug in the power supply and wait a minute or so for the tubes to warm up. If the tubes warm up at a slightly different rate, however, the hum level might be too loud. To prevent that, balance the circuit by adjusting R1 for minimum hum.

After the circuit is balanced, unplug the power supply. Connect the amplifier plate/screen lead clip to the proper clip on the power supply. Then, plug in the power supply and wait for the tubes to warm up again. When they do, the hum should be inaudible or nearly so. If it isn't, try moving the power supply away from the amplifier or change the physical orientation of the two circuits.

Unplug the power supply and remove the short from the input of the amplifier. Connect a battery-powered radio or tape player with an audio cable from its earphone jack to the amplifier input. Then, connect the filament-lead clip on the amplifier to the proper clip on the power supply. Plug in the power supply, adjust the volume control on the radio, and enjoy the music.



This power-supply prototype was built on a separate board from the amplifier. It's usually wise to build audio power supplies as separate units to prevent unwanted noise.

PARTS LIST FOR THE POWER SUPPLY

BR1—4-amp, 400-PIV, full-wave bridge rectifier
R1—330-ohm, 5-watt, 10% resistor
C1, C2—100-μF, 250-WVDC, electrolytic capacitor
T1, T2—117 volt to 12.6 volt, 3-amp, power transformer
PL1—3-conductor power cord and plug
9- by 4-inch pine board, terminal strip, fahnestock clips, screws, cable clamps, insulated wire, solder, hardware, etc.

Any distortion in the radio or tape player will, of course, be passed on to the amplifier (though "tube-philes" say tubes make it sound better!). Also, you'll find some music played over-the-air has built-in distortion—especially on "oldies" stations. Sound quality is also affected by sources that use bass boost, as they will sound "bassier" through the amplifier. So consider the above when making evaluations in the experiments that follow.

Some Experiments. There's long been a debate in tube-audio circles about pentodes *vs.* triodes. If you would like to hear the difference, try reconfiguring the amplifier for triode operation. To do that, disconnect the screen of each tube from R4. Then, connect the screen of each tube to its own plate at the appropriate fahnestock clip. The output and distortion should be less in the triode mode. Try both modes to see which you like better.

The idea of pushing a tube slightly beyond the linear portion of its operating curve was mentioned earlier. Some authorities say that tubes sound best when slightly over-driven that way. That is easy enough to try, just turn up the volume!

The push-pull arrangement of the tubes tends to cancel the even harmonics. You can put the harmonics back in by disconnecting the plate of one tube; however, hum might increase.

There is no "tone" control on the amplifier, but you can cut the highs and thereby boost the bass by connecting a 0.1-μF capacitor across the secondary of the input transformer. A variable resistor can be placed in series with the capacitor to make the effect adjustable.

You can sometimes cause subtle variations in amp and speaker performance by connecting a small resistor between the output transformer and the speaker system. Also, resistors can be used to experiment with the various forms of negative feedback. The open construction of the amplifier makes it easy to try them all. ■

Popular Electronics®

ANNUAL INDEX 1994 Volume 11

The Magazine for the Electronics Activist!

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Abbreviations: (AR)Antique Radio, (C)Construction, (CB)Computer Bits, (CC)Circuit Circus, (D)Department, (DX)DX Listening, (ED)Editorial, (HOR)Hands-On Reports, (HR)Ham Radio, (LTR)Letter, (MW)Multimedia Watch (PTR)Product Test Report, (SS)Scanner Scene, (TT)Think Tank

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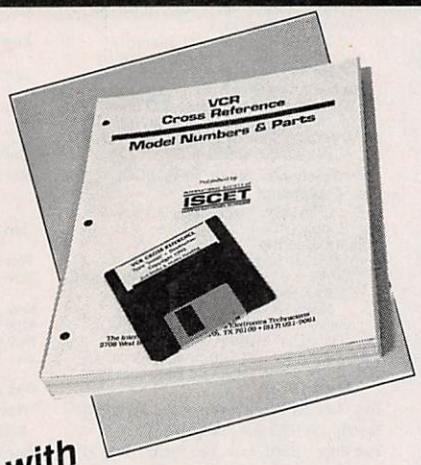

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ANTIQUE RADIO

By Marc Ellis

Tel-Ohmike Wrap-Up

For those of you who have just joined us, we've been in the process of rehabilitating and checking out a Sprague Tel-Ohmike Model TO-4 capacitor/resistor analyzer. Units similar to that one, intended for use by radio service technicians, were marketed by the major capacitor manufacturers, including Sprague, Aerovox, and Solar. Hobbyist-grade units, often sold in kit form, were offered by such companies as Heath, Allied Radio, and Eico.

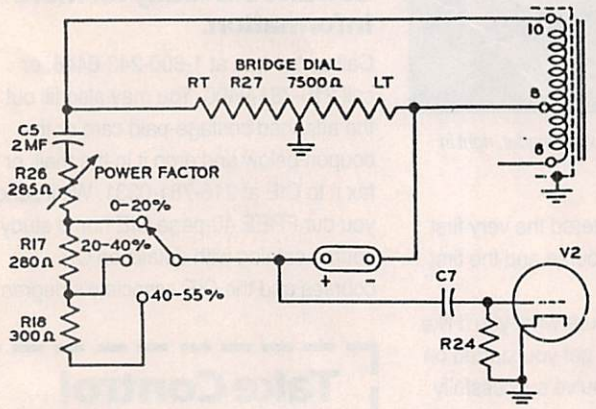

Fig. 1. This simplified schematic shows how the TO-4 is configured as a capacitance bridge on the 0.1–50-µF range. C5 (2 µF) is the reference capacitance for the range; V2 is the tuning-eye tube used to balance bridge.

Those analyzers are commonly available at hamfests and antique-radio meets, not too difficult to put in good working order, and make excellent additions to the antique-radio restorer's workbench. It's very handy to have the means to find the value of an unknown capacitance and to check an electrolytic or paper capacitor for leakage. Most analyzers will also measure resistance, but that's a function that I don't find too useful because it's more easily handled by a standard analog or digital multimeter.

LET'S CONTINUE

At the close of last month's column, we had checked most of the capacitance ranges, but were still in doubt about the next-to-highest (0.1 to 50 µF) and lowest (1 to 100 pF) ones. The former was tested with a decade capacitance box providing values from 1 to 10 µF, and it appeared that all of the Tel-Ohmike's measurements were about 1-µF low. The latter couldn't be tested because I didn't have any capacitors in the right size range to serve as "guinea pigs."

I began this month's work session with the thought that the reference capacitor for the 0.1–50-µF range had probably shifted in value and that I'd have to replace it. The capacitor (2 µF) is labeled C5 in Fig. 1, which is the schematic for the bridge circuit used in that capacitance range. (See last month's column for a detailed explanation of how bridge circuits are used to measure unknown capacitors or resistors.)

My first move was to remeasure each of the capacitances offered by the 1–10-µF decade box to verify that the TO-4 was as far off as I had thought. To my surprise, the measured values were now much closer to the nominal ones, with the percentage error quite consistent with that observed on the other ranges. The only explanation I can offer is that I was getting a bit tired at the close of last month's session and may not have been careful enough in setting up and reading the instrument. It does take a bit of getting used to.

THE LOWEST RANGE

Being a firm believer in the "if it ain't broke, don't fix it" philosophy, I immediately abandoned my plans to yank out and replace the 2-µF reference capacitor for the range in question. That meant I could move right along to the next piece of unfinished business, checking out the TO-4's lowest (1–100-pF) capacitance range.

In preparation for doing this month's column, I had stopped at the local Radio Shack store to pick up some 4.7-, 47-, and 100-pF ceramic capacitors. Those would allow me to check out both ends and the middle of the range. I found that the tuning-eye shadow wasn't as distinct on this range, but after learning how to interpret it, I was able to get satisfactory—and repeatable—results when measuring the 47- and 100-pF capacitors.

The measurement at 4.7 pF was a different story, however. The shadow was really vague here and difficult to read the same way each time. If I had to guess, though, I'd say that the TO-4 measured this capacitance as somewhere around 10 pF. Luckily, one isn't often faced with the necessity of checking such a low value!

CHECKING LEAKAGE IN ELECTROLYTICS

A very valuable feature of the TO-4 is its ability to check the leakage current

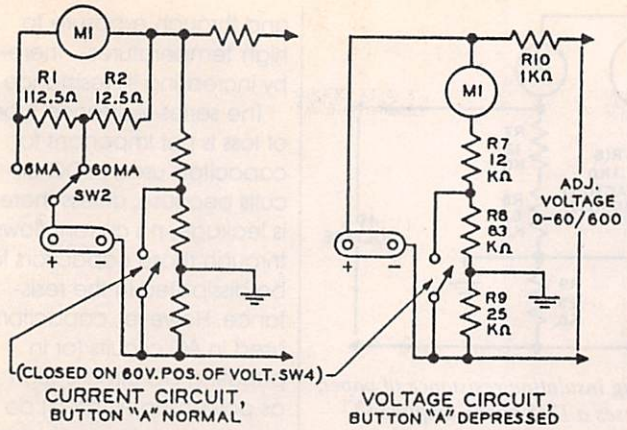

Fig. 2. Here are circuits for measuring the leakage current of electrolytic capacitors. The configuration depends on the position of button "A" (see text).

in electrolytic capacitors at actual working voltages up to 600 volts. The circuitry that accomplishes that is shown in Fig. 2. It could be configured as at left or as at right, depending on the position of front-panel button "A."

The terminals labeled "+" and "−" are the binding posts for the capacitor under test. The two circuit points terminated in arrows are connected to the adjustable voltage output of the 1619 grid-controlled rectifier tube. M1 is the front-panel meter.

When button "A" is depressed, M1, with its associated series resistors, becomes a 0–600 voltmeter connected across the capacitor-test binding posts (in the right-hand version of circuit). Using the voltmeter, the operator can set the voltage delivered by the rectifier to match the working voltage of the capacitor under test. When closed, the switch just to the right of the capacitor-test binding posts shorts out resistors R8 and R9, converting M1 to read 0–60 volts.

After setting the voltage appropriately, button "A" is released, changing the circuit to the one shown at left. The resistors formerly connected in series with M1 still remain across the voltage source, loading it down as before so that the supply voltage does not change. However, the M1, paralleled by shunt resistors R1 and R2, is now connected as a milliammeter in series with the capacitor-test binding posts and the voltage source.

Connected that way, M1 reads any leakage current that might pass through the capacitor being tested. By switching R1 in or out of the meter shunt, switch SW2 sets M1 to read 0–6 mA or 0–60 mA—accommodating a wide range of currents.

I checked several electrolytics from my "junk box" using that function, and found that the results were within the tolerances suggested in the TO-4's manual. As expected, capacitors that were very old exhibited much higher leakage than newer ones. In such cases, the operator is advised to reduce the voltage to a lower amount, then to advance it slowly to the nominal working voltage, giving the capacitor a chance to "reform."

If the capacitor is still in good shape, the leakage current will then be reduced to an acceptable value. Such was the case with the high-leakage capacitors that I happened to test.

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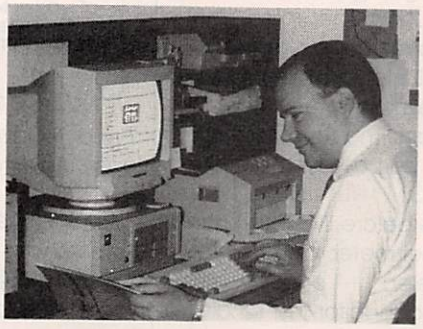

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CHECKING INSULATION RESISTANCE

While the TO-4 checks electrolytic capacitors for leakage by direct measurement of the current flowing through them at working voltage, typical current flow through paper, mica, and ceramic capacitors is so small that leakage must be tested by more indirect means. The test circuit for that purpose is shown in Fig. 3.

As before, M1 is the front-panel meter, the terminals labeled "+" and "−" are the capacitor-test binding posts, and the circuit points terminated in arrows are connected to the adjustable voltage output of the 1619 grid-controlled rectifier tube.

Tube V1 is a 12J5 triode connected as a simple amplifier. Meter M1 measures V1's plate current, which, at the start of the leakage test, is set to a standard value through adjustment of the voltage supplied by the 1619. That is accomplished by adjusting the voltage (with nothing connected across the test binding posts) so that M1's pointer falls on a "set" mark located at the meter's full-scale position.

The capacitor to be tested is now connected across the binding posts. Even the most minute leakage through the capacitor will increase the negative bias on V1, thereby decreasing the tube's plate current and dropping the meter pointer from its full-scale position. The greater the drop, the greater the leakage through the capacitor (and the lower its insulation resistance). A scale is provided on the meter (calibrated from 150–20,000 megohms) so that the insulation resistance of the capacitor can be read directly.

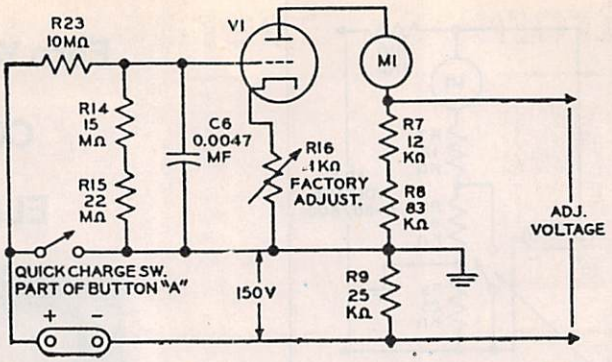

Fig. 3. The circuit for measuring insulation resistance of paper, mica, and ceramic capacitors uses a 12J5 triode amplifier.

Potentiometer R16, wired in series with V1's cathode, is a factory-adjusted calibration control located inside the instrument. The single-pole switch located above the capacitor-test binding posts, however, is a user-operated "quick charge" button located on the front panel.

The quick charge button is necessary because a stable insulation resistance reading can't be obtained on a capacitor until it is fully charged. Capacitors larger than 0.1 μF or so would take too long to reach that state,if the "quick charge" button were not held down for a few seconds. The button temporarily shorts out several series resistances, allowing 150 volts to appear across the capacitor under test.

I tested the insulation-resistance measuring function on several paper, mica, and ceramic capacitors and obtained readings consistent with the guidelines published in the manual. However, I don't consider it as useful to the restorer as the electrolytic capacitor leakage check.

In general, the non-electrolytic capacitors encountered during a restoration will be paper or mica. Mica capacitors almost never give trouble and don't have to be checked. The early wax-coated paper capacitors, however, are subject to deterioration because moisture and other contaminants in the atmosphere can penetrate their less-than-perfect seals.

Most restorers wouldn't bother to check the wax jobs. They are considered so unreliable that they are automatically replaced, even if they are good, with modern molded capacitors. Molded capacitors are well-sealed and rarely give trouble, even if stored for long periods of time prior to their use.

POWER FACTOR

A capacitor that is leaky can be imagined as having a resistor equal in value to the leakage resistance wired in parallel with it. Another capacitor quality problem can be represented by a capacitor having a *series* resistance. Such a resistance could be caused by poor internal connections, or by capacitor "plates" (or electrodes) that are not perfect electrical conductors.

In the case of electrolytic capacitors, series resistance can be appreciable because one of the "plates" is actually the paste film separating the two metallic surfaces that make up the capacitor. Not only does the paste have a much higher resistance than a metallic conductor, but it tends to dry out over time—and through exposure to high temperatures—thereby increasing its resistance.

The series-resistance type of loss is not important for capacitors used in DC circuits because, unless there is leakage, no current flows through those capacitors to be dissipated in the resistance. However, capacitors used in AC circuits (or in pulsating DC circuits such as power supply filters) do pass current during charge/discharge cycles and can have such losses.

A perfect capacitor would use no power, even in AC circuits, because during a discharge cycle, it would give back to the circuit as much power as it had absorbed during the charge cycle. The extent to which a capacitor is *imperfect*—that is, the extent to which it uses power through the combined effects of leakage and series resistance—is represented by the *power factor*, which is a number representing the percentage of power loss. The power factor must be measured at the frequency at which the capacitor will actually be used.

Because electrolytic capacitors are especially subject to losses through aging and exposure to heat, and are most frequently used in pulsating DC circuits as power supply filters, any quality test conducted on electrolytics should include a power factor check. In the TO-4, power factor (at the AC line frequency) is measured through adjustment of power-factor control R26 (see Fig. 1), as the bridge is balanced to determine the capacity of an electrolytic capacitor. The power factor, typically between 10 and 60, is read directly from a scale associated with the control. ■

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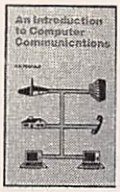

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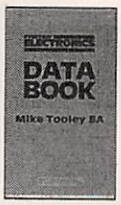

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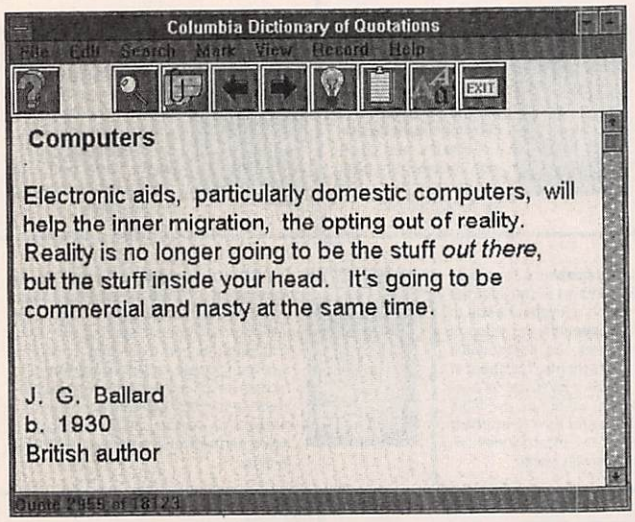
COMPUTER BITS

By Jeff Holtzman

Buy or Upgrade?

Should you buy a new machine or upgrade your current one? During the past year and a half or so, I have gone through the upgrade process. That process had its pluses and minuses. Although I certainly ended up with something that was better than what I started with, by the time I was finished, I spent about as much on upgrading as I would have on a new machine. Further, while i got the exact components I wanted, I had to assume the responsibility for making it work together. Was it worth it? To me, yes. But I wouldn't recommend it for everyone. To help you make up your own mind, here's the logic I followed:



The Columbia Dictionary of Quotations, though not CD-based, provides a more varied set of quotations than is typical of most CD products.

One of the first things that attracted me to the idea of upgrading was the emergence of super low-cost 486 motherboards. I ended up paying $139 for a board with: 256K of cache memory, the ability to install 11 different types of 486 and 486-clone chips via a built-in ZIF socket, the ability to hold up to 64 MB of memory, two VESA local-bus (VLB) slots, power management, and an Award BIOS.

Don't get me wrong; there was nothing wrong with my old 486 motherboard—a 486/25 for which I paid around $2200 a couple of years ago. Does it pain me that I got a new, better, faster board for 1/15th of what I originally paid? A little. But that's always the way it is in the computer business.

Of course, I could have just upgraded the video system (once seemingly speedy, it now seemed about as fast as fresh molasses in the Yukon), replaced the eight 1-MB SIMM's with four 4-MB jobs, wait another year, then buy some sort of Pentium screamer. But I just couldn't wait.

For one, I figured that by buying a new motherboard, I could pass the old one on to my kids, whose old Dell 386 was simply unable to keep up with the demands of multimedia Windows computing. From that point of view, I wasn't just selfishly upgrading my own computer; this was a family-wide upgrade as well! Of course, the $139 board then tripled in price because I had to pick up a new CPU as well. Not to mention the 16-MB SIMM for the new board, which set me back another $700.

After picking up the new motherboard, I backed up all the files on my present system to a Colorado 250-MB tape drive. Luckily, I made two full backups, because it turned out that there were some bad files in the middle of the first.

Then I swapped in the new motherboard (complete with the new, faster CPU and a single SIMM holding 16 MB), and, holding my breath, turned on power. My heart was literally pounding as I thought, "This cheap clone board is going to fry my whole system." But it didn't. In fact, the system came up the first time with absolutely no trouble, and has worked just fine since.

It seemed a little faster, but not nearly what I had hoped, so it was back to the drawing board. As for the kids' computer, after swapping in the old 486 board, it was a heck of a lot faster—just perfect for using CD-ROM-based learning tools such as the new *Columbia Dictionary of Quotations*.

DISK UPGRADES

I next attacked the disk subsystem. My old SCSI adapter was an 8-bit affair made by Always Technology. It had served me well, but part of my system upgrade involved using a copy of Corel SCSI to control a CD-ROM drive off the same controller as the hard disks.

That was the dark part of my adventure. The set up basically worked, but had a very nasty habit of just stopping dead in its tracks in a totally unpredictable fashion. For a while I just ignored the problem. Eventually I realized it was not going to go away, so I started doing some troubleshooting. It wasn't too hard to track down the source of the problem.

If I didn't load the man-

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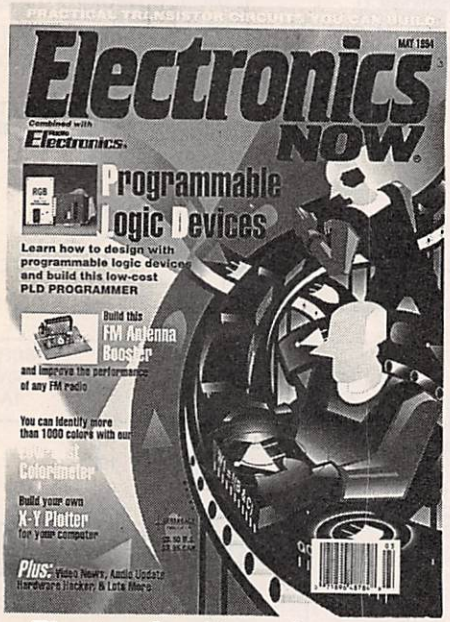

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ufacturer-supplied CD-ROM device driver, everything worked fine. I tried upgrading the drivers, several times in fact, but to no avail. Eventually I learned that the Always drivers disable software interrupts for a short time, and that could cause Windows to crash.

The solution was to upgrade the SCSI adapter, and my contacts indicated that Adaptec cards were the standard for reliability and compatibility. The next question was whether to buy a 16-bit (ISA) or a 32-bit (VLB) card. The 16-bit card cost around $200, and the 32-bit card around $400. I ended up springing for the VLB card (an Adaptec 2840). The good news was that using the Adaptec card and drivers, I no longer needed the Corel drivers; in addition, the random crashes unequivocally stopped. The bad news was that there was no discernible speed increase.

Later I found out that although the card conformed to the SCSI-II standard, the three hard drives I had were all of SCSI-I vintage, including one I bought just a few months earlier. To get the speed increase promised by the 32-bit VLB bus, I would need to get SCSI-II drives. That has yet to happen. However, my local clone shop is currently selling brand new 2.4-gig SCSI-II Micropolis drives for about $1100, complete with a five-year factory warranty. I've got one of those targeted for later in 1995.

At that point in my upgrade binge, I had noticeably better Windows performance (due to the faster CPU and double the memory), and a reliable system. But I still lacked the speed increase that was the object of the whole exercise. Next time we'll pick up where this leaves off, and I'll point out a way of drastically increasing system performance for a more modest investment than I made. See you then. ■

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THINK TANK

(Continued from page 29)

ters, R6 and R7. The threshold voltage is supplied through R5, which is connected to a voltage divider made up of R4 (a temperature-adjust potentiometer), R3 (a series resistor to set the range), and R1 (a negative-temperature-coefficient thermistor).

Let's assume R6 and R7 are set so that the voltage at pin 3 of U1 is lower than that at pin 12. As the temperature drops, the resistance of R1 increases and the voltage at the inverting inputs (pins 2 and 13) decreases. When the temperature is low enough, both comparators are saturated, so Q1, SCR1, and the relay (K1) are activated.

As the temperature rises, the voltage at pin 2 increases. When the voltage at pin 2 is greater than that at pin 3, the gate current to the SCR is removed. However, the SCR will continue to conduct until its anode-to-cathode current is interrupted. As the temperature continues to rise, U1-b turns off, thereby turning off Q1. That removes current from the SCR and the relay turns off. Now the thermistor begins to cool to the point where U1-b turns on. As cooling continues, U1-a turns on and the output circuit is complete, closing the relay.

To calibrate the circuit, I used a 60-watt light bulb connected to the relay. It was a simple procedure to use the heat from the bulb and a digital thermometer to set the trip points of the comparators. The differential is determined by the difference in the trip-point voltages. Setting the voltage at pin 3 100-millivolts higher than that at pin 13 produced a differential of about 3 degrees. Resistor R2 is used to help straighten out the very non-linear response of the thermistor. If the input comparator inputs are transposed, the circuit can be used to control a cooling device.

—Bob MacIsaac, Nova Scotia, Canada

As with our other circuits, select K1 to handle the load you have in mind. By the way, you should set R4 according to the cut-in temperature you want. ■

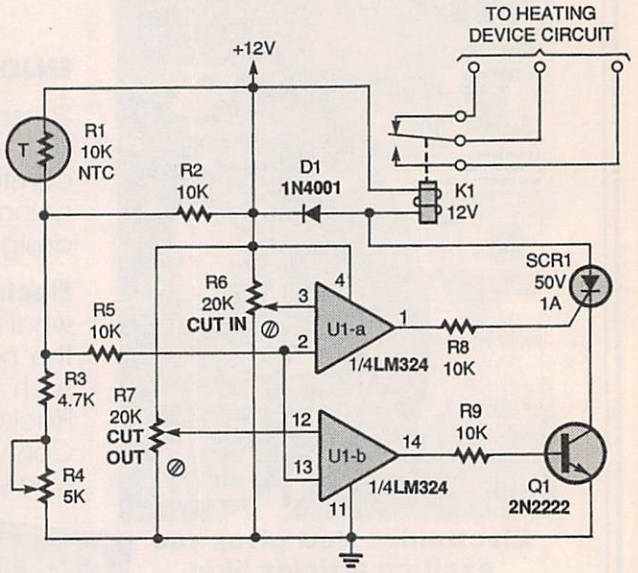

Fig. 3. Since the SCR latches once it is turned on, and will not activate without Q1 on, this circuit has built-in hysterisis.

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By Charles D. Rakes

More Ultrasonic Circuits

Circuiteers, gather around the old work bench and join me in celebrating our 100th get-together here at the Circus. We certainly have shared a number of circuits since our first meeting back in August of 1986, and it's my hope to do even better as we speed toward the next century. But to do so, I need your help. Let me know, through your letters to me via **Popular Electronics**, what circuits you would like to see appear, and any ideas that you would like to share in making our visits more useful, educational, and just plain fun. If you would like a personal reply, please enclose a self-addressed, stamped envelope. Now let's carry on where we left off last month with more ultrasonic circuits.

ULTRASONIC TRANSMITTER

Our first entry takes to the air waves in the form of a CW (Morse code) transceiver. The circuit, see Fig. 1, uses the versatile, 567 phase-locked-loop IC as the transmitter's signal-source generator as well as the receiver's detector. The 567's dual circuit functions allow for a much simpler transceiver design.

Here's a close look at the CW transceiver's receiver operation. With the telegraph key at S2 "up" (open), the 567 PLL's input at pin 3 is coupled to the output of Q3. Transistors Q3 and Q4 are operating in a high-gain, two-stage audio-amplifier circuit. The piezo speaker is coupled to the input of the amplifier through a 0.1-μF capacitor and a 680-ohm isolation resistor.

In the receive mode, the piezo speaker operates as a sensitive microphone. Ultrasonic signals travel from the microphone through the two-stage amplifier to the input of the 567, and, if the signal's frequency is within the IC's bandwidth, the LED will light and piezo-sounder BZ1 will sing out for each "dit" and "dah" received. The receiver may be tuned to the incoming ultrasonic signal by adjusting R17. Of course, adjusting that potentiometer also changes the transmitter's frequency.

In receive, transistor Q2 is biased on through R3 and R4, with its collector clamping the 567's square-wave output, at the junction of R12 and R18, to ground. No signal can pass to the base of Q1 in the receive mode. The collectors of Q5 and Q6 are like open circuits in the receive mode and do not load the speaker's (microphone's) output.

The transmitter operates each time the S2 is closed. When the key is closed, diode D3 supplies a path to ground for BZ1, causing that sounder to produce an audible signal for each dit and dah transmitted. Also, Q2's bias is taken to ground through D2, allowing Q1 to pass the 567's square-wave signal on to the input of the power amplifier and out through the speaker.

You will need to build two transceivers to carry on a CW "rag chew" with a friend. The transceivers will operate inside or out, but the range can be affected by the wind, as well as

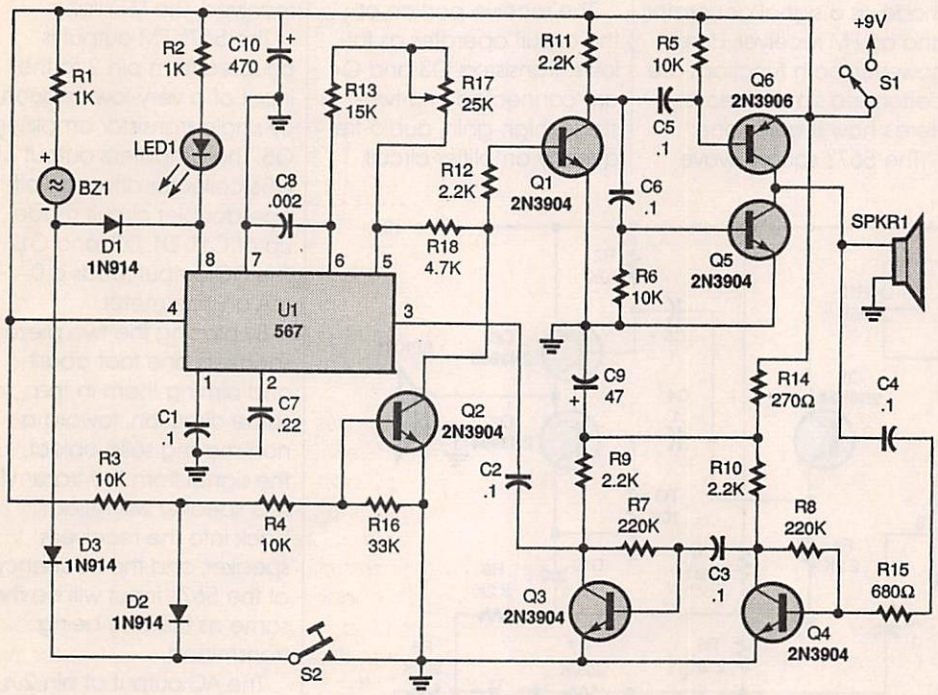

Fig. 1. Get on the "air" with this ultrasonic CW receiver. For the greatest flexibility, its receive and output frequency can be adjusted via R17.

PARTS LIST FOR THE ULTRASONIC TRANSCEIVER (Fig. 1)

SEMICONDUCTORS
U1—567 phase-locked loop, integrated circuit
D1–D3—1N914 silicon diode
LED1—Light-emitting diode, any color
Q1–Q5—2N3904 NPN transistor
Q6—2N3906 PNP transistor

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1–R2—1000-ohm
R3–R6—10,000-ohm
R7, R8—220,000-ohm
R9–R12—2,200-ohm
R13—15,000-ohm
R14—270-ohm
R15—680-ohm
R16—33,000-ohm
R17—25,000-ohm, potentiometer
R18—4,700-ohm

CAPACITORS
C1–C6—0.1-µF, ceramic disk
C7—0.22-µF, Mylar or similar
C8—0.002-µF, Mylar or similar
C9—47-µF, 16-WVDC, electrolytic
C10—470-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
SPKR1—Piezo-tweeter speaker
BZ1—Piezo buzzer
S1—SPST switch
S2—Telegraph key
Wire, solder, IC sockets, etc.

heating or air-conditioning air currents. You can transmit around corners by bouncing the ultrasonic signal off walls, doors, or anything solid. If you wish, you can experiment by changing the circuit's frequency to obtain the greatest operating distance and reliability. You can even tune the CW transceiver to a high (audible) frequency.

MOTION DETECTOR

Our next entry is a motion detector circuit. The circuitry, shown in Fig. 2, is in some ways similar to our previous circuit. A 567 PLL IC operates in a dual-function mode as a signal generator and an FM receiver. Here, however, both functions are performed simultaneously. Here's how that is done:

The 567's square-wave output at pin 5 is coupled to the base of Q1, and from Q1's emitter to the input of the power amplifier made up of Q2 and Q6. The output drives the piezo speaker, SPKR1.

The receive portion of the circuit operates as follows: Transistors Q3 and Q4 are connected in a two-stage, high-gain, audio-frequency amplifier circuit, with the input connected to a second piezo speaker (SPKR2) operating as a sensitive microphone. The amplifier's output is coupled to the 567's input at pin 3. When an in-band signal is received, the LED lights.

The 567's FM output is coupled from pin 2 to the input of a very-low-frequency single-transistor amplifier, Q5. The amplifier's output at Q5's collector drives a voltage-doubler circuit made up of C11, D1, D2, and C12. The DC output feeds a 0–1-mA analog meter.

By placing the two piezo speakers one foot apart and aiming them in the same direction, toward a non-moving solid object, the signal from the transmitter's speaker will reflect back into the receiver's speaker, and the frequency at the 567's input will be the same as the one being transmitted.

The AC output at pin 2 is zero when the outgoing and incoming frequencies are the same. However, when the signal is reflected from a moving object, the received frequency will be either lower or higher than the transmitted one. If the object is moving away from the speakers, the received

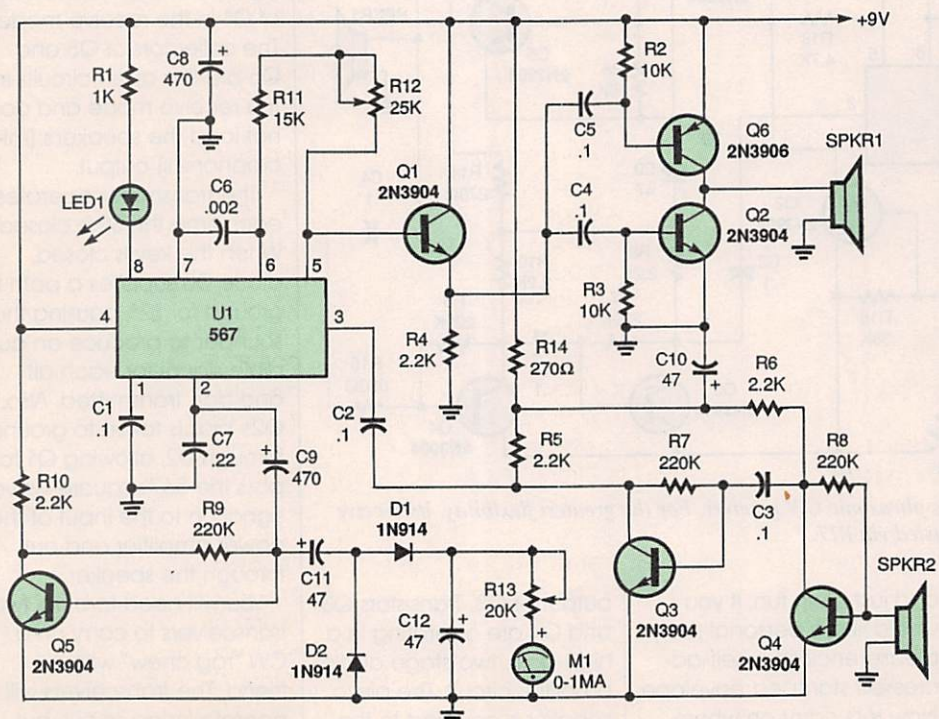

Fig. 2. In this ultrasonic motion detector, if an object moves in front of the speakers, a signal is produced at pin 2 of the 567 PLL.

frequency will be lower; if the object is moving toward the speakers, the frequency will be higher. That is due to the Doppler effect.

Regardless of the direction of the movement, the difference in the received and transmitted signal will cause a low, audio-frequency difference output to appear at pin 2. That pin-2 signal is fed through a 470-μF capacitor to the base of Q5, where the signal is amplified and fed to a voltage doubler, and then on to a meter circuit.

If you wish, the voltage-doubler and meter can be removed and replaced with headphones connected between the negative side of C11 and circuit ground. That will allow you to listen to the difference-frequency signal as objects move in front of the speakers.

PROXIMITY SENSOR

Our last entry this visit is an audible proximity circuit that can be used as a liquid-level detector, a proximity-operated switch, or as a sensor for robotics projects.

The circuit is shown in Fig. 3. The pick-up sensor, BZ1, is a Mallory Sonalert solid-state signaling device that is normally used as a low-level alarm sounder. But in our circuit it is used as a variable-"Q" load-sensitive oscillator.

Here's how the simple alarm sounder is turned into a useful proximity sensor. A 100K potentiometer, R4, sets the current fed to the Sonalert sounder. The potentiometer is adjusted to a point where the sounder just begins to make an audible sound. A single-transistor audio amplifier (Q1) is coupled to the positive side of the sounder and its output is fed to a voltage-doubler circuit. The doubler's DC output drives the base of Q2, which, in turn, operates the relay (K1). As long as the Sonalert is producing a sound, the relay stays energized.

When a solid object is moved in close proximity to the front of the sounder, the "Q" of the piezo element is lowered and the Sonalert's internal oscillator circuit ceases to operate; as a result, the relay drops out. By carefully adjusting R4, the circuit can be made quite sensitive. The proximity sensor is a fun circuit to play with, so why don't you give it a try and see what unusual application you can find for it.

Looks like we've just about used up our allotted space for this month. Before we finish, however, I want to correct an error in one of the circuits that appeared in October, 1994. In Fig. 7 that month, resistors R2 and R3 are reversed. A few sharp-eyed readers wrote in to tell me about that one. I hope it didn't cause anyone too much confusion.

Until next time, you can send your letters to me at Circuit Circus, *Popular Electronics* Magazine, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

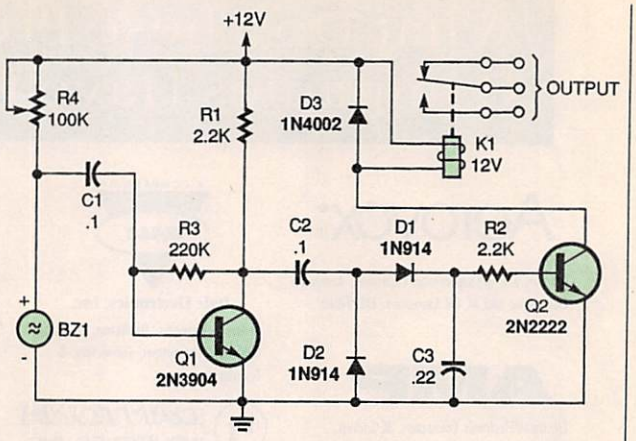

Fig. 3. This proximity sensor uses a common piezo sounder, a Mallory Sonalert, in a rather unusual way.

PARTS LIST FOR THE MOTION DETECTOR (Fig. 2)

SEMICONDUCTORS
U1—567 phase-locked loop, integrated circuit
D1, D2—1N914 silicon diode
LED1—Light-emitting diode, any color.
Q1–Q5—2N3904 NPN transistor
Q6—2N3906 PNP transistor

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—1,000-ohm
R2, R3—10,000-ohm
R4–R6, R10—2,200-ohm
R7–R9—220,000-ohm
R11—15,000-ohm
R12—25,000-ohm, potentiometer
R13—20,000-ohm, potentiometer
R14—270-ohm

CAPACITORS
C1–C5—0.1-μF, ceramic disk
C6—0.002-μF, Mylar or similar
C7—0.22-μF, Mylar or similar
C8, C9—470-μF, 16-WVDC, electrolytic
C10–C12—47-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
M1—0–1-mA meter
SPKR1, SPKR2—piezo-tweeter speakers
Wire, solder, IC sockets, power source, etc.

PARTS LIST FOR THE PROXIMITY SENSOR (Fig. 3)

SEMICONDUCTORS
Q1—2N3904 NPN transistor
Q2—2N2222 NPN transistor
D1, D2—1N914 silicon diode
D3—1N4002 silicon diode

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1, R2—2,200-ohm
R3—220,000-ohm
R4—100,000-ohm, potentiometer

CAPACITORS
C1, C2—0.1-μF, ceramic disk
C3—0.22-μF, Mylar or similar

ADDITIONAL PARTS AND MATERIALS
K1—12-volt relay
BZ1—Mallory Sonalert sounder, model SC628
Wire, solder, power source, etc.

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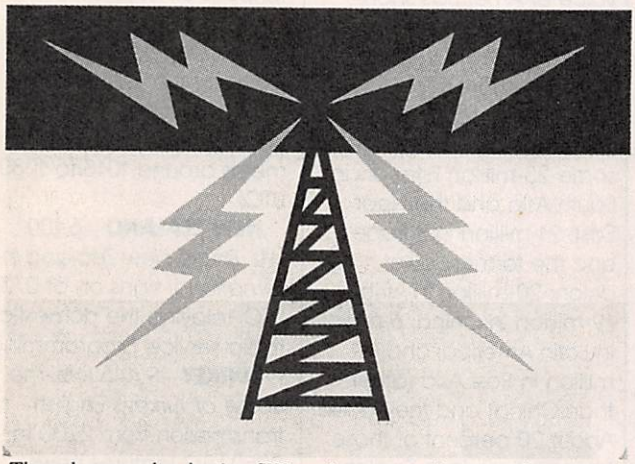
DX LISTENING

By Don Jensen

Helping Beginners

Sometimes it is hard to remember that not everyone who reads this column is an experienced shortwave listener. In fact, the ranks of this wonderful hobby are swelling all the time with newcomers. Well, because this is the first column for 1995, I'd like to make all the newcomers a promise: During the coming year, I'll try to include in each column at least some basic information about SWL'ing that may help you.



Though most clandestine SW stations are quite secretive, some have replied to SWL's reports. In past years, this QSL card was sent out by Radio Vatan, a clandestine that targeted its anti-regime political broadcasts at Iran.

Probably the best way to do that is to respond to your questions about shortwave listening. You can send them to me, Don Jensen, at DX Listening, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. I look forward to hearing from you!

In the meantime, I've got a few questions on hand to start the ball rolling. So, let's not waste any more time and get right to them.

A MATTER OF TIME

Here is a basic question about a subject that confuses a lot of new listeners: "Can you explain the international time used by shortwave listeners?" asks Leif Anderson, Mankato, MN.

Sure, Leif. In this column you regularly will see time information given like this: 0215 UTC, or 2130 UTC. There are two things you need to know to use that information.

The first is the 24-hour (sometimes referred to as the "military") time system. To prevent confusion between a.m. and p.m., the hours from 1 a.m. to 11 a.m. are designated 0100 to 1100 hours. Those from 1 p.m. to 11 p.m. are designated as 1300 to 2300 hours. Noon is 1200 hours. Midnight is 2400 hours, but one minute past midnight is 0001 hours. Therefore, 0215 is 2:15 a.m., and 2130 means 9:30 p.m.

The second thing to know is that UTC stands for Universal Coordinated Time (the old term for that was Greenwich Mean Time, or GMT, and ex-GI's will know it as Z or Zulu time). Because the stations we listen to on shortwave are located all over the globe, and the listeners to which they broadcast are likewise widely scattered, it is useful to give all time references in a single standard time, the hour at the 0-degree, or Greenwich meridian. That is UTC.

Listeners in North America should know that UTC is equivalent to Eastern Standard Time plus 5 hours, Central Standard Time plus 6 hours, Mountain Standard Time plus 7 hours, and Pacific Standard Time plus 8 hours. During daylight savings time, the differences are EDT + 4, CDT + 5, MDT + 6, and PDT + 7 hours. So, in our example above, 0215 UTC means 2:15 a.m. at the 0-degree (Greenwich) meridian, which is equivalent to 9:15 p.m. EST (9:15 EST plus 5 hours = 0215 UTC).

The only other factor to remember is that when the UTC hour passes midnight, the day/date moves ahead. So 9:15 p.m. EST Monday is equal to 0215 UTC Tuesday. If a station's schedule says that a certain program is aired at 0215 UTC on Tuesdays, you should tune in at 9:15 p.m. Mondays, if you live in the eastern time zone. If you live in the CST, MST, or PST zones, of course, your local listening times would be 8:15 p.m., 7:15 p.m., or 6:15 p.m., respectively.

Though their local clocks will read differently, SWL's in New York, Chicago, Denver, and San Francisco will all be tuned in to the program at the very same time, 0215, UTC. I hope that straightens things out for you.

LISTENERS' CLUBS

Next, we hear from Willie Martin, Lancaster, CA who is both a newcomer and an old timer. He writes: "I was an active shortwave listener in the mid 1960's and early 1970's, but military service overseas caused an interruption of more than 20 years.

"Now I have retired from the Air Force and would like to resume SWL'ing. I've been reading **Popular Electronics** and I saw a reference in your column to the Southern California Area DX'ers and the Ameri-

can Shortwave Listeners' Club. I'd like to know the addresses of those clubs so I can contact them."

Welcome back, Willie! SCADS, a hobby radio club whose membership is limited to southern California listeners, can be contacted by writing to 6398 Pheasant Drive, Buena Park, CA 90620. The address of ASWLC, which accepts members from anywhere in the world, is 161 Ballad Lane, Huntington Beach, CA 92649.

Those two are among 16 organizations affiliated with the Association of North American Radio Clubs (ANARC). Various clubs cover the different aspects of the listening hobby, including shortwave, medium wave and longwave bands; FM and TV DX signals; and scanner monitoring.

For a list of all 16, with their addresses, membership fees and other pertinent information, send a stamped, self-addressed business-size envelope to ANARC Club List, Association of North American Radio Clubs, Dept. PE, 2216 Burkey Drive, Wyomissing, PA 19610.

CLANDESTINE BROADCASTERS

Next, Luis Garcia, San Antonio, TX, writes, "Last month, a Margaret Lewin asked about clandestine broadcasters. I've never heard one of them. Are there any of those guerrilla stations operating in Central or South America? Where can I hear them?"

How about an anti-government Guatemalan clandestine shortwave voice, Luis? Canadian DX'er, Robert Ross reports that *Voz Popular* operates in Spanish on 7,000 kHz on Tuesdays and Fridays from 2300 to 0045 UTC, and on 3,500 kHz from 0200 to 0300 UTC.

Ross has spoken with one of the station's representatives in Canada who says that Voz Popular operates a 2,000-watt transmitter from a secret site within Guatemala, in the jungles of the Sierra Madres near the Tajulmulco volcano.

VOA AUDIENCE PROFILE

Approximately 92-million adults regularly listen to the *Voice of America's* shortwave and medium-wave programs, the U.S.-government-sponsored broadcaster reported last year. That breaks down to some 25-million listeners in South Asia and the Near East; 21-million in Europe and the former Soviet Union; 20-million in Africa; 19-million in China; 6-million in Latin America; and 1-million in East Asia (other than China) and the Pacific. About 20 percent of those listeners tune in to English programming—the rest to VOA's various language services.

Research, the VOA says, indicates that the American international broadcaster attracts an audience that is generally young, male, and well-educated, though that does vary in different parts of the world.

DOWN THE DIAL

What's an SWL to do? Well, try tuning in to some of these stations, which others have been hearing recently.

CROATIA—5,920 kHz. *Croatian Radio* is noted at 0600 UTC with Croatian music followed at 0605 UTC with English news.

CYPRUS—6,195 kHz. The *BBC* English language programming heard on this frequency at 0220 UTC reportedly is broadcast from relay transmitters on this Mediterranean Island.

FRANCE—9,805 kHz. *Radio France International* airs English programming at 1220 UTC on this frequency and also, in parallel, on 15,530 kHz.

JAPAN—3,925 kHz. *Radio Tanpa* is a home-service broadcast in Japanese. It has been logged on the west coast of North America with jazz music and identification announcements around 1015 to 1030 UTC.

NEW ZEALAND—6,100 kHz. *Radio New Zealand International* signs on at 0735 UTC, relaying the domestic radio-service programming.

TURKEY—9,445 kHz. *The Voice of Turkey's* English transmission from 2200 to 2250 UTC features news, commentary, historical features, and Turkish music. You can find it on 11,710 kHz at the same time.

UKRAINE—11,950 kHz. *Radio Ukraine International* is heard in a one hour English transmission beginning at 2100 UTC. That includes news and commentary, as well as Ukrainian folk music. ■

*CREDITS: Brian Alexander, PA; Jim Lane, ONT CAN; William Mayer, PA; William McGuire, MD; Ed Rausch, NJ; Doug Robertson, CA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057

"Jack, I think there are still a few bugs in this automotive navagation system."

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A Step Attenuator Project

By Joseph J. Carr, K4IPV

An attenuator is a device or circuit that reduces a signal level by a specified amount. The attenuation factor is usually expressed in terms of decibels (dB). For RF circuits, an attenuator's input and/or output impedance is 50 ohms. That is, a circuit looking into either the input side or the output side of an attenuator would see a 50-ohm resistive load (by the way, most attenuator circuits are bilateral, *i.e.* either port could be used as either an input or an output).

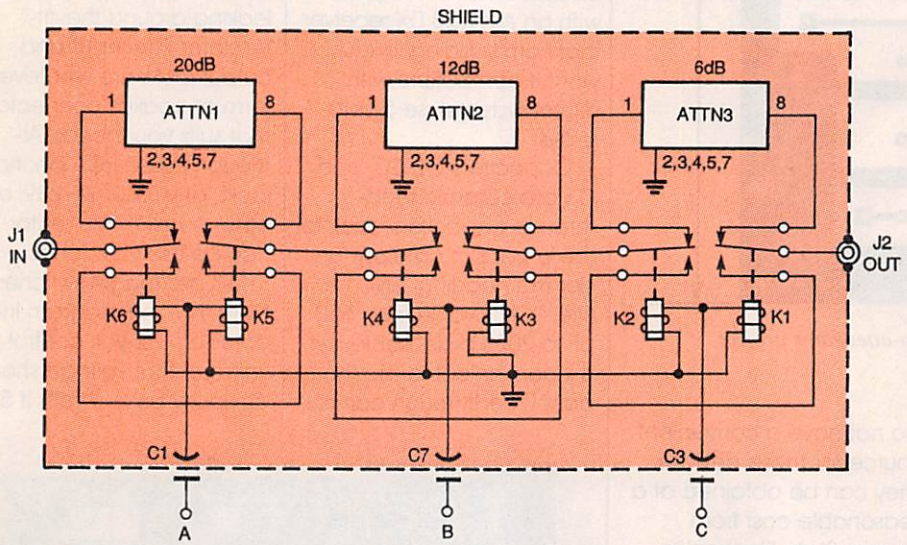


Fig. 1. Here's the schematic diagram for the basic step-attenuator circuit. The level of attenuation depends on which of the three attenuator pads are selected via the inputs at A, B, and C.

FIXED ATTENUATORS

A fixed attenuator provides only one level of attenuation. For example, a 6-dB attenuator reduces the power of the input signal by 6 dB. Fixed attenuators are commonly available with 1-, 3-, 6-, 10-, 12-, 20-, and 40-dB attenuation factors.

The main use of fixed attenuators is to reduce the signal level by a fixed amount. One reason might be to prevent overdriving some circuit or device. Another reason is to make comparison measurements. A number of receiver measurements require comparing two signal levels, or the levels of two or more signals, for a standard output level.

Yet another use for fixed attenuators is to "swamp" the inputs and outputs of circuits. Some circuits, such as LC filters, double-balanced mixers, and others, don't work as intended when faced with input or output loads other than the designed 50-ohm system impedance. To overcome, at least somewhat, problems caused by load-impedance variations, some designers place a 1-dB attenuator in series with the signal. Similarly, oscillators will pull in frequency if the load impedance varies, so, in lieu of a proper buffer amplifier, some designers will put an attenuator in line with the output circuit.

A main use for an attenuator, and one of my own principal interests, is in the front-end of radio receivers. By being able to switch an attenuator in or out of the circuit, one can effectively raise the dynamic range of the receiver by the amount of the attenuation factor while suffering only a small increase in the noise floor. Most modern ham and SWL H.F-band receivers have at least one fixed attenuator, and many use a 6-, 12-, and 20-dB array that is similar to one that will be presented later in this column. In some receivers, the attenuator can be switched in or out of the signal path according to the automatic gain-control (AGC) level.

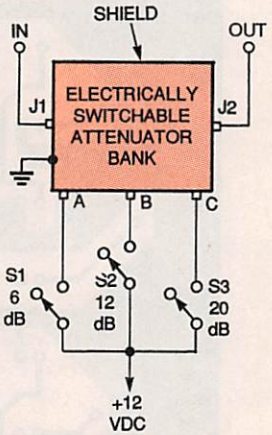


Fig. 2. The control-signal voltage (shown here as +12VDC) should be changed to +5VDC if 5-volt relays are used.

A STEP ATTENUATOR PROJECT

A step attenuator consists of several fixed attenuators that can be switched in or out of the circuit as needed. For example, the

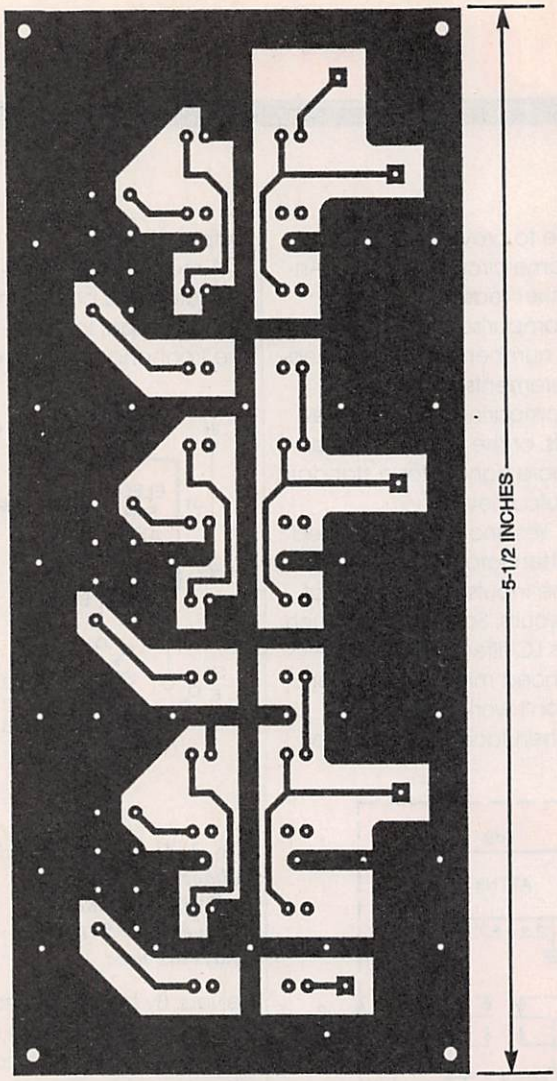


Fig. 3. This foil pattern for the step-attenuator project is shown here full sized.

step attenuator project that we are presenting this month (see Fig. 1) has 6-, 12-, and 20-dB attenuator pads, allowing the user to select attenuation levels of 6-, 12-, 18-, 20-, 26-, 32-, or 38-dB. Signals presented to inputs A, B, and C are used to set the attenuation level; more on that later.

Turning to the circuit itself, attenuators ATTN1, ATTN2, and ATTN3 are Mini-Circuits AT-20 (20-dB), AT-12 (12-dB), and AT-6 (6-dB) units. Those fixed attenuators are housed in IC-like packages with 0.100 inch pin spacing so they will fit onto perforated board intended for DIP integrated circuits. If you do not have a convenient source for those devices, they can be obtained at a reasonable cost from Ocean State Electronics (P.O. Box 1458, 6 Industrial Drive, Westerly, RI, 02891; Tel. 401-596-3080, Orders: 800- 866-6626, Fax: 401-596-3590).

The attenuators are switched in and out of the circuit by relays K1 through K6. Those relays can be any SPDT DIP delay, but if you wish to use the printed circuit board (more on that in a moment), they must be EAC D1C05H (5-volt) or D1C12H (12-volt) units, which are available from Digi-Key (P.O. Box 677, 701 Brooks

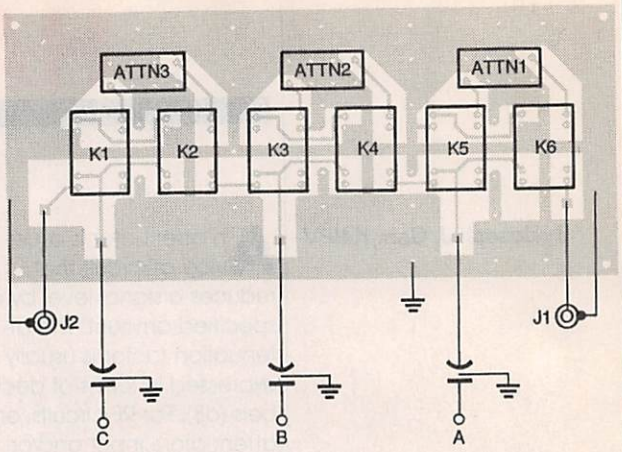


Fig. 4. Use this parts-placement diagram when assembling your board. The finished project should be placed in a metal enclosure; see text.

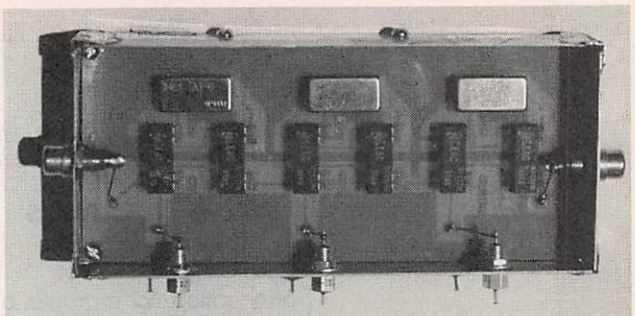
Avenue South, Thief River Falls, MN, 56701-0677; Tel. 800-344-4539) as part numbers Z663-ND (5 volt) and Z664-ND (12 volt). I used 12-volt units in my prototype because that is compatible with an AM BCB DX receiver that I am building; if you want it compatible with digital systems use 5-volt relays.

Capacitors C1, C2, and C3 are ceramic feedthrough capacitors. Look for these parts in catalogs under the heading "EMI filters." Any value from 500 pF to 2000 pF is usable. If it is inconvenient to use the panel feedthrough capacitors, or if the parts prove to be too expensive for your budget (they can cost as much as $7 each from some sources!), then use 0.001-µF ceramic-disk capacitors instead.

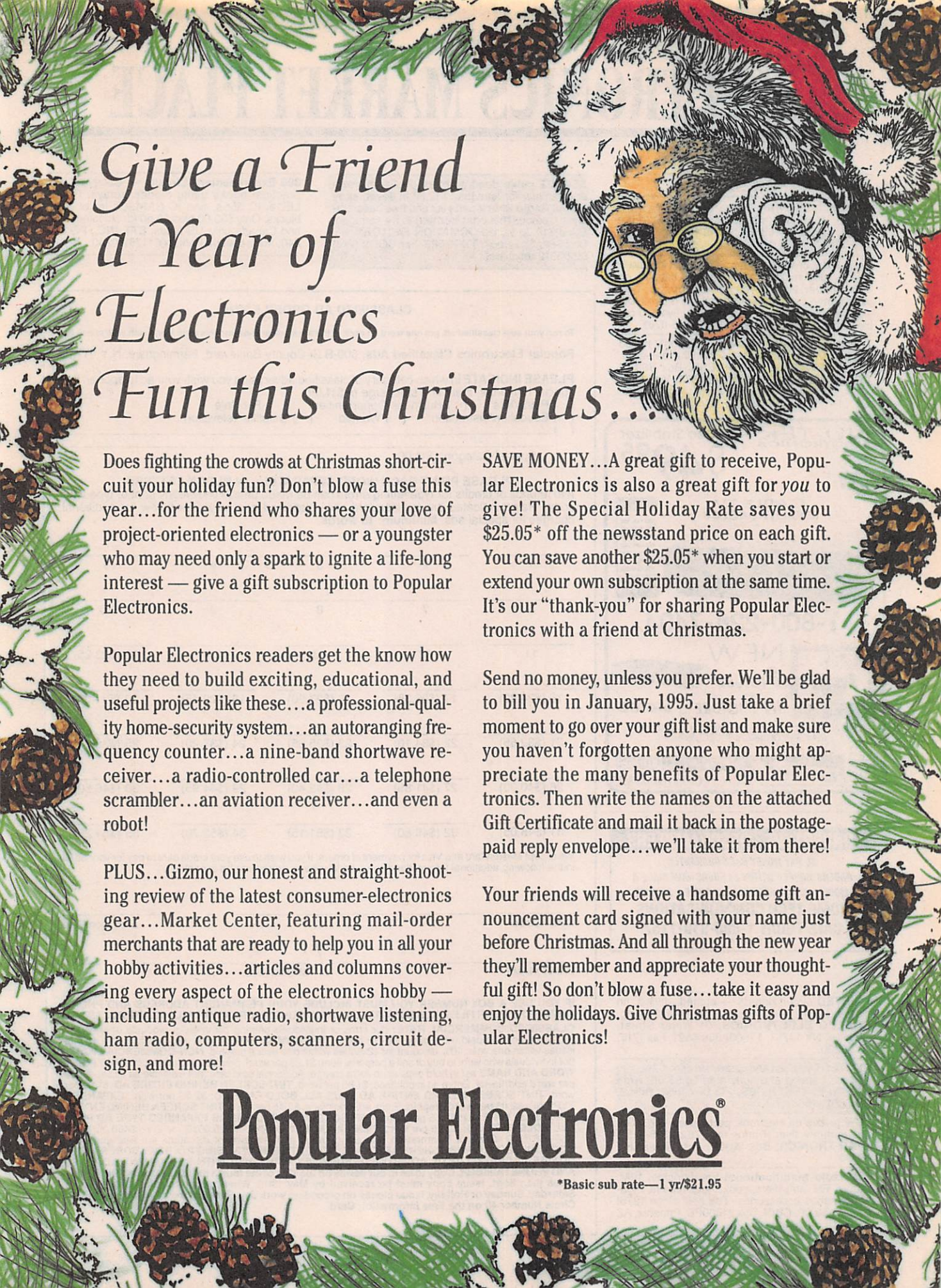
Figure 2 shows the external connections to the attenuator circuit. The entire circuit is built inside of a shielded box or container (mine was homebrew), in order to prevent signal from leaking around the attenuator. The input and output jacks are whatever form of coaxial connector that suits your needs. Although I used RCA phono jacks, any BNC, SO-239, or other coaxial connector can be used. Switches S1–S3 are toggle switches. Note that the diagram indicates a +12-volt control voltage; that voltage should obviously be +5 volts if 5-volt relays are used in your circuit.

A printed-circuit-board layout is shown in Fig. 3, and its corresponding parts-placement diagram

(Continued on page 83)



This photo shows the completed project ready for use. The feedthrough capacitors are shown along the lower edge of the enclosure.



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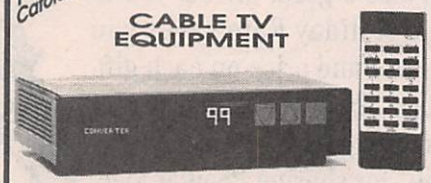

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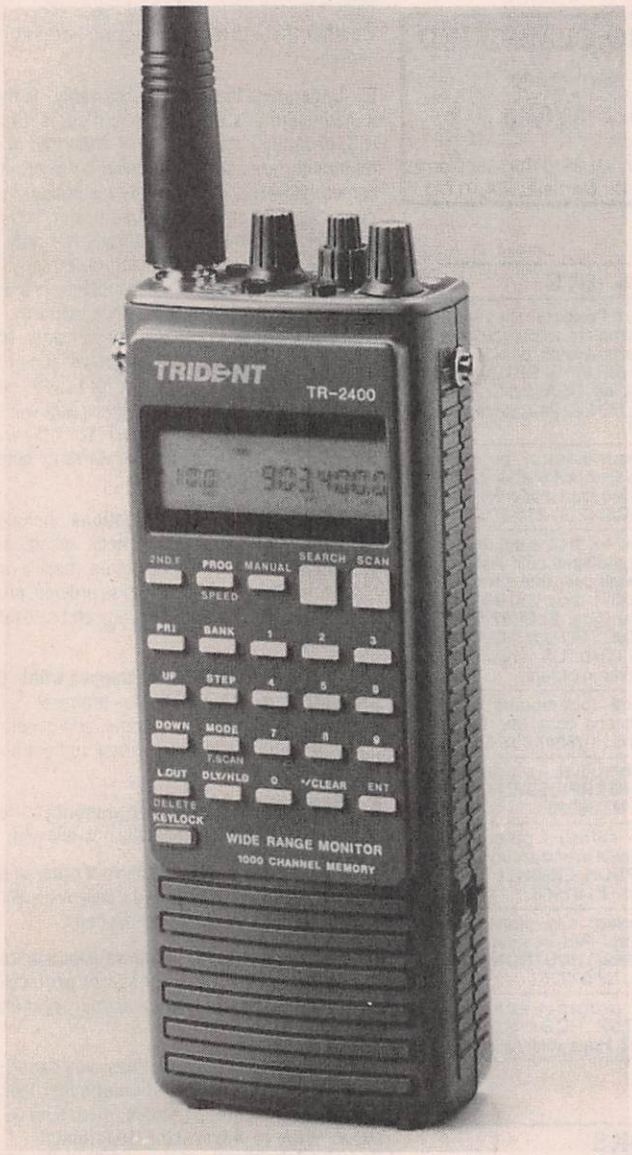
SCANNER SCENE

By Marc Saxon

Monitoring VIP Military Aircraft

A smart-looking, new handheld scanner, the *Trident TR-2400*, carries "Innovations '94" honors awarded by the Electronic Industries Association. Those honors are given to the most innovative electronic products of the year.



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The handheld scanner operates in AM, NFM, and FM modes, and can also receive single sideband (SSB) mode signals. Tuning increments are selectable, and go as low as 1-kHz steps for extra-fine tuning. The unit scans at 25 channels per second.

Despite its many features, the Trident TR-2400 weighs in at only 14 ounces, and measures approximately 6 inches high by 2 inches wide by 1.5 inches deep. It runs on four AA batteries. A lot of potential in a small package!

For more information on the versatile Trident TR-2400, call ACI at 1-800-445-7717 or 317-849-2570.

PLAY IT AGAIN, SAM

To many monitoring enthusiasts, SAM is more than the name of the world's most memorable piano-bar performer. SAM is the military acronym for "Special Air Mission," which is how the U.S. Air Force classifies those particular VIP flights carrying heads of state, cabinet members, senators and congressmen, and high-ranking officers.

Communications monitors know that it's easy to sort out SAM flights from the others because their callsigns consist of the distinctive word "SAM," followed by digits representing the individual aircraft—for example, SAM-972 or SAM-345. The aircraft used by the President and Vice President are also SAM flights, and may be heard identifying as SAM-26000 and SAM-27000 when the President and Vice President are not aboard. Otherwise, they normally identify as Air Force One and Air Force Two.

VIP travelers get special attention from the media, baggage handlers, and everyone else. The use of a SAM callsign announces to ground stations that there is a priority status. Some scanner owners know that SAM flights turn up on certain frequencies set aside for their exclusive use. You might want to try them, as they can get interesting.

Many people know that Air Force One has an air/ground telephone downlink on 415.70 MHz. That is almost always operated in the clear, and sometimes you can also (poorly) hear the voice of the other party replying, when it is repeated through the aircraft's system. The uplink frequency is 407.85 MHz, and there are more than 60 ground transmitters located throughout the U.S. and Canada. That ensures that Air Force One and Two, or any SAM flight, will always

be able to make contact via the private "Echo–Foxtrot" phone circuit. The ground transmitters are all remotely controlled from the White House Communications Center ("Crown").

When Air Force One and Two are on the ground, or flying in a local area, they have available the "Yankee–Zulu" private telephone circuit, which has seldom been reported. The aircraft operates on 171.2875 MHz, with the ground station, located locally, on 162.6875 MHz.

While in flight, Air Force One and Two are sometimes accompanied by civilian aircraft, such as commercial charters or airliners used by the media. Communications between the pilots takes place on 129.525 MHz.

The home base for all SAM flights is Andrews Air Force Base in Maryland. At that base, several scanner-band frequencies are reserved exclusively for communications with SAM aircraft, and they can be copied working Andrews from hundreds of miles away. Listen for Andrews to identify as "SAM C.P" (Command Post) on 141.55, 361.6, 372.5, and 378.1 MHz. VIP helicopters at Andrews use 141.70, 292.2, and 375 MHz.

Some of the more esoteric communications believed to be from Air Force One have been noted on 246.95, 305.55, 322.75, 326.0, 336.8, 345.5, 361.6, 362.35, 366.0, 390.0, and 397.05 MHz. Those frequencies have variously been observed by scanner users as using AM, WFM, USB, LSB, and multiplex downlink transmissions. Not long ago, I tuned in 361.6 MHz and observed a multiplex operation going on. That meant that it was a single wide signal that contained several independent simultaneous conversations.

The signal extended to ±50 kHz from the center frequency. Putting the scanner into AM mode, I slowly sifted upward and downward through the garbled maze in 5-kHz steps. I was able to extract a few of the conversations, although with poor quality and with some heterodyning.

This column has received a lot of mail over past months providing information on, and asking questions about, SAM VHF/UHF communications. Looks like it's a topic that interests our readers. I hope that this month's column provides a good start for those who want to know more. Remember, also, that SAM missions outside of North America operate in SSB mode on long-range communications frequencies below 30-MHz.

MESSAGE FROM THE BERMUDA TRIANGLE

Reader William G. Cave lives on Summerland Key, Florida, which he points out is at the intersection of Hurricane Alley and the Bermuda Triangle. William started listening to police radio stations back in the days when the stations operated around 2400 kHz. Then he followed them to the 30–50-MHz band, and to the 150–160-MHz range. Now he writes that the police agencies he wants to monitor have gone to 860 MHz with digital scrambling, trunking, data terminals, and whatever. He asks if this all could mean the end of police scanning.

I don't believe so, although it certainly inhibits the ability to monitor police in the largest and most active agencies. Thousands of medium and small agencies don't feel that those costly systems are needed for their purposes. ■

HAM RADIO

(Continued from page 78)

is shown in Fig. 4. An etched PC board is also available. You can either build this board yourself, or buy one from FAR Circuits (18N640 Field Court, Dundee, IL, 60118). The price isn't available as of this writing, but Fred at FAR made my prototype for a very reasonable price (indeed, FAR tends to be a low-cost source of PC boards, and will make your design without the terrible set-up fees that many other sources charge).

Because my version of the digital attenuator is going to be mounted inside of a receiver chassis, it was not necessary to buy a wonderful manufactured cabinet for it. I made a shielded enclosure out of 1.5-inch width, 22-gauge, brass sheet stock. That material is available from hobby shops, model shops, and shops that cater to amateur jewelers (typically called "rock shops" or "lapidary shops" in the Yellow Pages). I bent the stock into the shape of the box, and then soldered the joints using a standard 150-watt soldering gun.

NEW PARTS CATALOG

When preparing this column, I called Frank Pellicano at Ocean State Electronics to make sure they carry the attenuators, along with some of the other Mini-Circuits products. Frank told me that they now have their 1994–1995 catalog on the street. If you are an electronics hobby builder, especially a ham-radio builder, then that catalog is sure to be of real interest to you. ■

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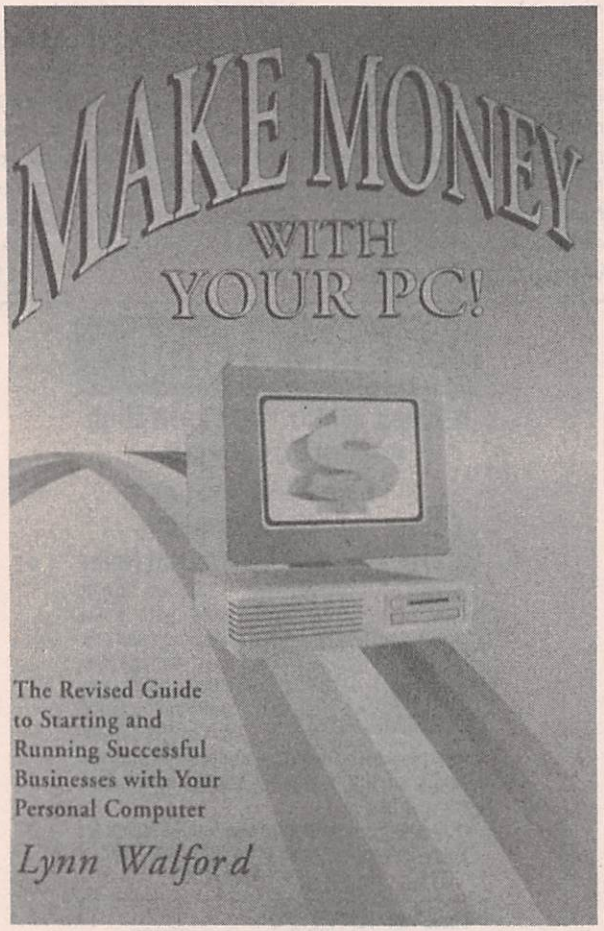

The book helps you determine if you have what it takes to become an entrepreneur, how to decide what business best suits your skills and talents, and how to evaluate and choose software and hardware. It offers plenty of successful business ideas along with practical advice to get your business off the ground—including how to get established; how to market and manage your business; how to price, bill, and get paid for your services; and where to go for help.

Exercises at the end of each chapter make it easy to develop business marketing and management plans, and to set and accomplish goals. Brainstorming sessions are also included to inspire sessions with friends, colleagues, or family members and stimulate new and exciting ideas.

The revised edition of the book also contains examples of how other computer-based business owners became successful, and illustrations of common mistakes. For those who already are running computer-based businesses, the book provides new ideas on increasing business and profits and avoiding potential client problems.

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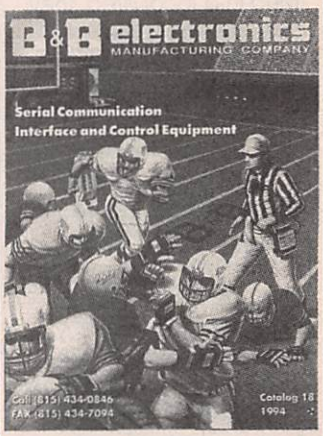

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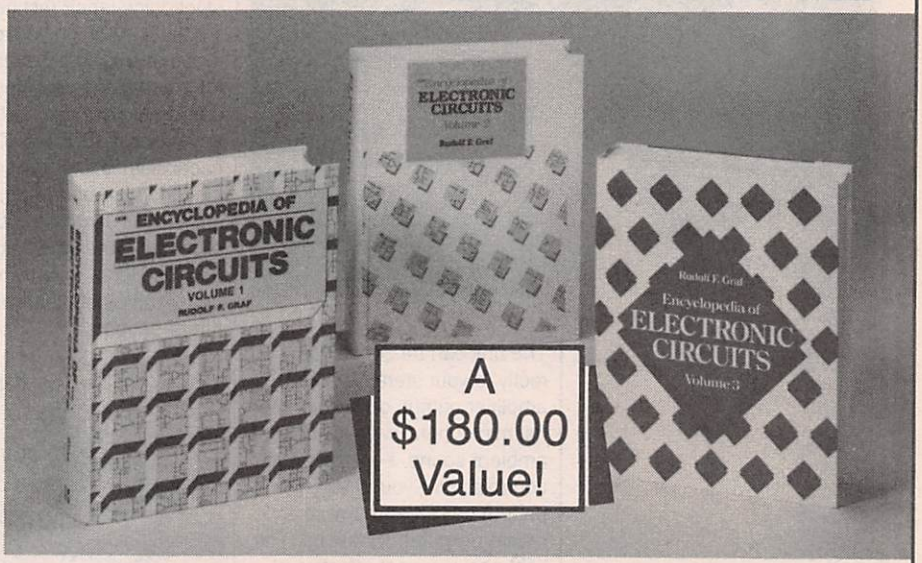

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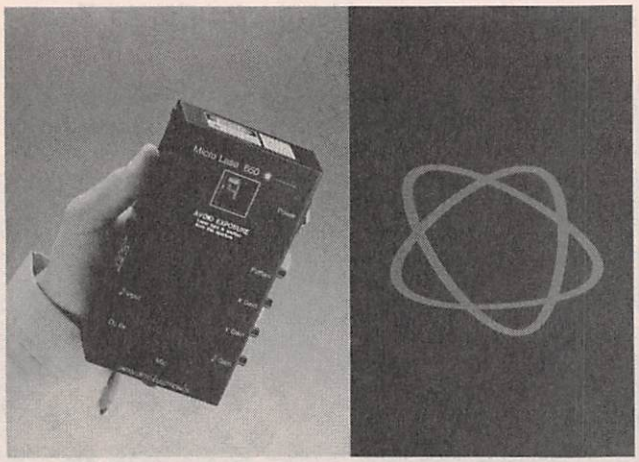
You can create fantastic laser light effects anywhere with the handheld *Micro Lase 650* from *Edmund Scientific*. About the size of a portable radio, the compact device uses diode laser technology to create effects that pulsate and change in response to musical input.



The unit can be connected directly to your stereo system's amplifier output, or its own internal microphone will pick up ambient sound. Four separate controls allow you to vary the pattern design and size to create unlimited variations. The light show is most effective at projection distances of up to 50 feet, but the Micro Lase 650 will project as far as 200 feet. It is most dramatic in darkened areas. It runs on four "AA" batteries, or with the included 117-volt power supply.

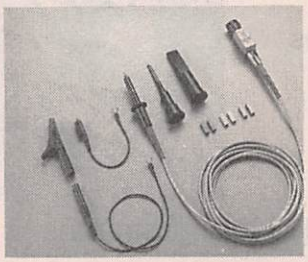
The Micro Lase 650 (order number E52 570) costs $499. For more information, contact Edmund Scientific Company, Department 14A1, C999 Edscorp Building, Barrington, NJ 08007; Tel. 609-573-6250; Fax: 609-573-6295.

CIRCLE 101 ON FREE INFORMATION CARD

HIGH-VOLTAGE OSCILLOSCOPE PROBE

The *Model P5100* 2.5-kV probe from *Tektronix* is the first high-voltage (above 1.5-kV) oscilloscope probe to win safety certification from Underwriters Laboratory (UL). UL certification also qualifies the probe for safety certification by two international standards-setting organizations: the European Economic Community's IEC (International Electrotechnical Commission) and Canada's CSA (Canadian Standards Association). The probe can be used by industrial motor and power supply designers as well as automotive and aircraft service personnel and consumer-electronics repair technicians.

The P5100 high-voltage probe offers a bandwidth of 250 MHz and the lowest input capacitance (less than 2.75 pF) of any probe in its class. Those capabilities allow users to exploit the high-bandwidth capacity of Textronix' TDS300-, 400-, and 500-series digitizing oscilloscopes, or maximize the performance of other manufacturers' scopes.



The probe has accessories designed for safely gripping large, high-voltage test points. Those accessories include a retractable hook tip, useful for gripping bolts up to ¼-inch in diameter, and for holding the probe in place while making signal measurements. Using the hook tip, rather than securing the probe with wires, eliminates a high-voltage-testing safety hazard.

The P5100 high-voltage probe costs $199. For further information, contact Tektronix, Measurements Group, P. O. Box 1520, Pittsfield, MA 01202; Tel. 1-800-426-2200.

CIRCLE 102 ON FREE INFORMATION CARD

INDOOR/OUTDOOR TEMPERATURE ALARM

The *Model 401012* indoor/outdoor temperature alarm from *Extech* provides simultaneous readings of indoor and outdoor temperatures on a large 1.5-inch LCD. The compact unit offers a wide measuring range of −58°F to 170°F (accurate to 0.1°). The indoor temperature sensor is built in; the external sensor includes adhesive backing for easy mounting and ten feet of cable. A single-point

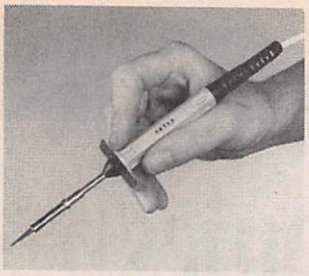
alarm for the external sensor warns the user that the temperature is either above a high limit or below a low limit. A dual-point alarm for the external sensor alerts the user that the temperature is either within or outside the range of two set points. The alarms are both audible and visible (red/green LED).

The 401012 indoor/outdoor thermometer, complete with waterproof outdoor sensor, cable, built-in stand, and AAA battery, costs $19. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154-1020; Tel. 617-890-7440; Fax: 617-890-7864.

CIRCLE 103 ON FREE INFORMATION CARD

MINIATURE SOLDERING IRON

Designed for user comfort, the *Antex Model G/3U* miniature soldering iron from *M.M. Newman* features a protective heat shield. The heating element is located under the tip for optimum thermal efficiency. The pencil-thin plastic handle always stays cool, and the iron fits



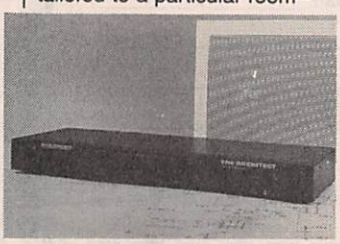
comfortably in the hand for hours of electronic assembly work. The 18-watt unit puts out the same power as a bulkier 30-watt iron. It heats up to 750°F in only 45 seconds and recovers rapidly. The G/3U measures 6½ inches in length and weighs 3/4 of an ounce. It uses slide-on tips that come in more than 40 styles, including needle points, spades, cones, and chisels.

The Antex Model G/3U miniature soldering iron, including a standard tip, has a list price of $21.95. Replacement tips are priced from $1.95. For additional information, contact M.M. Newman Corporation, 24 Tioga Way, P. O. Box 615, Marblehead, MA 01945; Tel. 617-631-7100; Fax: 617-631-8887.

CIRCLE 104 ON FREE INFORMATION CARD

SPEAKER BOOSTER

Bookshelf, in-wall, and compact speaker systems don't have to sound small, according to *AudioControl*. The *Architect* electronic processing system is designed to improve the performance of small loudspeakers. The heart of the device is its speaker optimizer system, described as "a sort of tool kit for building better sound from 2- and 3-way speaker systems with 4-, 6-, or 8-inch woofers. 45-Hz (low bass), 150-Hz (mid bass), 700-Hz (midrange), and 12-kHz (treble) band centers are provided to optimize small speakers at where adjustment is most advantageous. Bass output can be carefully enhanced, and strident midrange can be mellowed. Highs can be tailored to a particular room—boosted in heavily carpeted and upholstered rooms or reduced in rooms filled with hard surfaces.



Intended for use with virtually any receiver, preamplifier, or integrated amplifier, the Architect is a "set and forget" component. Because it should be adjusted only during information, it uses rotary potentiometers instead of sliders, which are more prone to being fiddled with by the curious. Plus and minus 12-dB adjustments provide ample control for reducing acoustic problems and maximum output at usable frequencies.

The Architect speaker optimizer has a suggested retail price of $189. For more information, contact AudioControl, 22410 70th Avenue West, Mountlake Terrace, WA 98043; Tel. 216-775-8461; Fax: 206-778-3166.

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WEARABLE "HEADLIGHTS"

Bright Eyes Pro Headlights from *Wahl Clipper Corporation* provide a practical solution to repair and maintenance situations, in dimly lit areas, that require both hands for the job—and none for holding a flashlight. Worn like eyeglasses, the lightweight headset features a small bright flashlight on either side of the head. As the technician moves from task to task, so does the light, always aimed directly at the job at hand.

The Bright Eyes Pro Headlights have a suggested retail price of $13.95. For additional information, contact Wahl Clipper Corporation, 2900 North Locust Street, P. O. Box 578, Sterling, IL 61081-0578; Tel. 815-625-6525; Fax: 815-625-1193. ■

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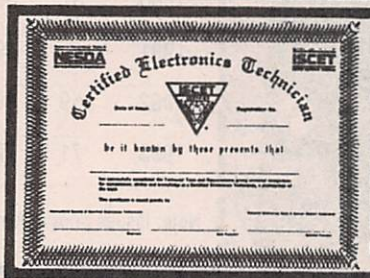

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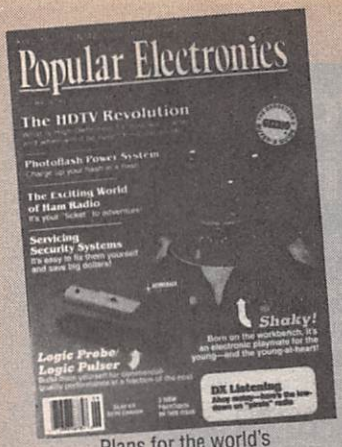

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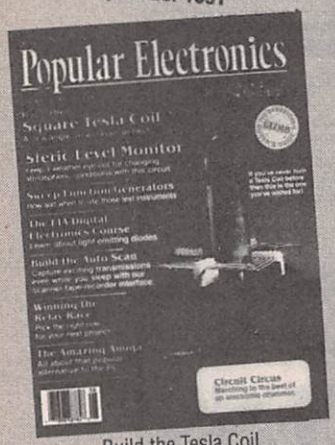

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TELEPHONE LINE ANALYZER

(Continued from page 24)

structions only show you how to perform each test to get a go/no-go result. The detailed instructions, however, fully describe each test and show you how to correct problems that give bad test results.

The Tutorial. For those interested in thoroughly understanding phone technology, the tutorial offered with the analyzer kit is invaluable. The tutorial's first section—Telephone Operation—describes the connection between a phone and the phone company's central office. It also describes, in general terms, what happens when you place a call.

The next section, which is on rotary-dial telephones, presents a simple diagram of an old-style phone for use with most of the later sections. Of course, it explains how contemporary phones are more modern in design, but the remainder of the text is written in such a way that the diagram is useful nonetheless.

The next section discusses a phone's hook switch, which detects if the phone is off-hook. In that section, the values of both off-hook current and voltage are presented.

Both rotary and tone dialers are discussed next. During the discussion of old-style pulse dialers, the timing of dial pulses for both the US and Europe is supplied. A mechanical explanation of how pulses are generated is also given. The section on tone dialers covers the frequencies used to generate DTMF (dual-tone, multi-frequency) signals, and how they are generated in a touch-tone type phone.

Next, a phone's transmitter is discussed. Both carbon granule and electret-microphone mouth pieces are reviewed separately. For contrast purposes, the section on receivers uses a speaker analogy to explain how all types of receivers work.

The section on ringers, like the other sections in the tutorial, is thorough. Both the electromechanical and piezoelectric types are discussed in depth.

The little-understood, induction-coil balancing network is covered in the last section. As the instructions explain, that part of a phone allows the user to hear his or her own voice through the receiver at an acceptable volume level.

The completed kit, with its custom panel meter and label, looks as good (and works as well) as any manufactured unit.

Kit Assembly. From the soldering tips in its beginning to the assembly instructions that follow, the manual included with the kit is thorough and easy to follow. There's a checklist-style parts list for inventory checking, as well as step-by-step assembly instructions with pictorial diagrams (*a la* Heathkit). Like the parts list, there is a box next to each assembly step so you can check it off when it is completed.

The first set of instructions describes how to install parts on the PC board. It then goes on to explain the process for mounting the meter onto the cabinet. The next two sections show you how to connect the modular jack and modular socket to the PC board. Next, instructions for wiring the meter to the board are given. The final-assembly instructions describe the physical construction of the unit.

After the assembly sections, the manual provides calibration instructions. For calibration, all you need is a small screwdriver, a 20- or 40-volt DC source, a 20-mA current source (which can be improvised by using an adjustable voltage source), and a meter to measure voltage and current. You only need to adjust two potentiometers to complete the calibration procedure.

A component-check section comes after the calibration procedure. The component-check section guides the user through the examination of the polarity of components and connections, and is a precursor to the troubleshooting section that follows. Because the kit is pretty simple to put together, troubleshooting is reduced to nothing more than checking your soldering.

At the very end of the manual (after the instructions for use), there is a 10-question multiple-choice quiz, so you can gauge your understanding. Rather than asking questions about the analyzer, the quiz focuses on how phone systems work.

On the whole, the kit is easy to build and functions well. The instructions for construction and use are clear and concise. When you build the analyzer, you end up with a device that looks and acts like a commercial unit, and learn a lot in the process. Add to that the fact that the unit can save you some money, and the kit's cost is more than justified.

If you want more information on the Telephone Line Analyzer, contact Elenco Electronics, Inc. at the address given earlier, or circle No. 119 on the Free Information Card. ■

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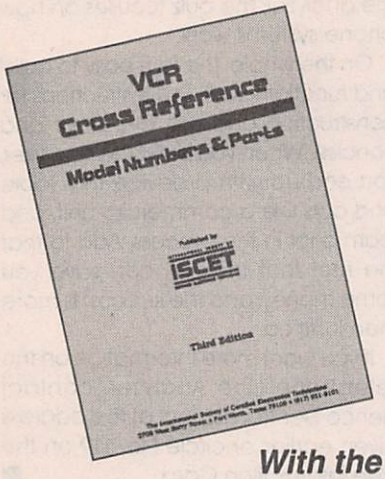

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This 270-page reference contains both model and part-number cross-references updated to include 1992 units.

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TELEPHONE-LINE SIMULATOR

(Continued from page 39)

A power switch was not used in the prototype. Although a power control is not necessary, you can add an SPST type toggle switch in series with the primary of T1.

Connect the main board to the power-supply board using short lengths of insulated wire. Wire the square pad to the square pad, the center-tap (CT) pad to the center-tap pad, and the remaining pad to the remaining pad.

Be sure to trim any long component leads. After assembly, clean the solder flux off the circuit boards. Commercial solvents are available that do a terrific job of removing the flux residue.

Mount the two circuit boards on short standoffs in an enclosure of your choice. Be careful when mounting the power board; *do not* allow it to come in contact with the conductive surfaces of your cabinet! Position the power board in your enclosure so that T3 is a minimum of two inches from T1 and T2. If they are placed too close together you may hear power-line AC hum on the telephone audio.

Test and Check-Out. Disconnect any telephone equipment plugged into the line-1 and line-2 phone jacks. Remove the JU1 power-up-mode configuration jumper. Install the JU2 CPC-configuration jumper. Adjust R14 (which sets the audio level) to about the middle of its range.

Turn on AC power and verify that the LED display shows "r." for a moment then shows "n." (normal mode). Press the mode switch and verify that it can be cycled through the five different modes (n, A, b, c, and d).

Remove power and install the JU1 configuration jumper. Turn on AC power and verify that the LED display shows "r." for a moment then shows "A." (automatic mode).

Set the unit to the normal mode ("n."). Connect a standard telephone to the line 1 (main) modular phone jack. Pick up line 1 and verify that a dial tone can be heard. If you are using a DTMF phone, dial a digit and verify that the dial tone stops and the digit is shown on the LED display.

Hang up the phone; then lift the handset again. Verify that you can hear a dial tone again. Press the ring switch once and verify that a ringing sound can be heard in the telephone handset (it should sound like an authentic ring signal). Pressing the Ring switch again or hanging the phone up will terminate the ring sound and return the dial tone.

Plug a second telephone into the line 2 (test) jack. Pick up the line-1 phone and again press the ring switch. Verify that the line-2 phone's bell is activated. It should ring with a cadence similar to a standard ring pattern.

Try the remaining operational modes. For example, set the mode to "A" to have line 2 ring whenever line 1 is lifted off-hook.

Beep- and Cycle-Mode Operation. To use the beep or cycle modes with the delay feature, connect an answering machine or telephone to line 2. If you are using the cycle mode, be sure to also install a phone in the line-1 jack. Start line-2 ringing by lifting the line-1 phone off-hook (cycle mode) or pressing the ring switch (beep mode).

While the test line is ringing, you can adjust the delay potentiometer from 10–90 seconds by viewing the LED display; the display will show a readout of 1 to 9. If the delay cycle has already started (as seen by the chasing LED pattern), you can press and hold the ring switch to review the delay-count setting.

When line 2 is answered, a series of beeps will be generated that will make most voice-operated (VOX) answering systems stay on the line (if they are operating correctly). If you want to force the answering system to periodically hang up, just use that unit's VOX time limit switch.

Keep line 1 off-hook if using the cycle mode. After the answering machine (or telephone) hangs up, it will be cycled on again every 10–90 seconds, depending on the R35's setting. At any time you can cancel the beep or cycle modes by pressing the Mode switch.

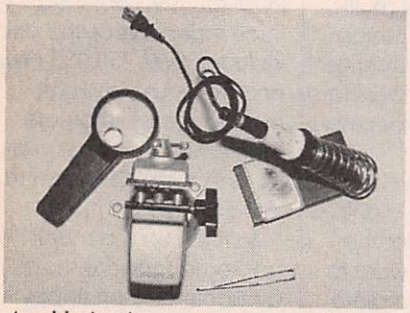
Conclusion. Using Ring-It! couldn't be easier. Plug the equipment to test or demonstrate into line 2 and use the line 1 telephone to place calls to it. Now that you're ready to use your Ring-It! project, reach out and touch someone. ■

SURFACE-MOUNT

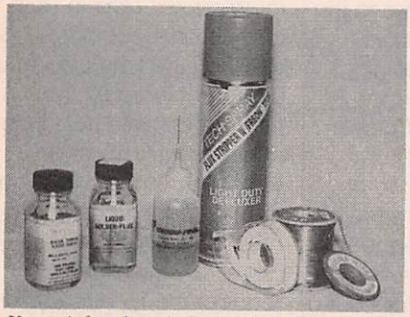
(Continued from page 48)

10. Inspect your work under a magnifying glass. Especially look for solder bridges.

Unfortunately, there will be times when you'll need to remove a component (wrong component, component in backwards, component severely misaligned, etc.). As a general procedure, dip solder wick into liquid flux, place it over the lead or pin, and apply heat with a soldering iron. When all possible solder has been removed, the component should lift up with a slight pull.



A soldering iron, a tweezers, a vise, and a magnifying glass are the only tools you need to get started.



You might already have these necessary materials on your workbench.

Getting Your Hands on SMC's. Hopefully, you're eager by now to obtain some surface-mount components and see what the excitement is all about. Doing so will probably be easier than you might have thought. There are two factors to consider: cost and availability. The good news is that with regard to both, things are definitely moving in the right direction.

During the late 1980s, SMC's were 20 to 30 percent higher in price than equivalent, through-hole components. Today, however, pricing is at parity with traditional components, at least for the more common devices. In the near future, SMC's should cost less than their insertion mount equivalents.

Availability is of more concern than price. Yet the situation is improving daily. Most electronics mail-order distributors have a line of SMC's that they sell in single-lot quantities. True, not all of your favorite transistors, IC's, diodes, and indicators are yet available in surface-mount configurations. But most are. The box entitled "SMC Distributors" lists a few of the major distributors where the author has purchased SMC's. Call, fax, or write to those and other companies for a catalog. You will be surprised at the extent of their SMC offerings.

Practice, Practice, Practice. So far, the basic characteristics of the most popular surface-mount components, the knowledge of how to handle and solder them, and sources for their purchase have all been dealt with. But there is still one important step left to complete the SMT learning experience: SMC soldering practice. After you have practiced awhile, you can move on to SMT project building—the subject of a future article. So for now, how do you get a hold of both SMC's and a PC board to practice surface-mount assembly techniques? There are two ways to go about it.

One, you can disassemble a stuffed, surplus SMT PC board—that is, remove the SMC's from it and solder new ones in place. Be sure, however, to use new SMC's. Never attempt to reattach a previously removed SMC—it just isn't worth it.

Two, Electronics Goldmine, listed in the "SMC Distributor" box, sells two low-cost SMT "Learn to Solder" kits that contain a PC board and a teaspoon full (which means hundreds) of SMC's. They're great kits to practice with. Contact the company for details.

Whichever way you choose to practice your SMT assembly techniques, try getting started as soon as possible. A whole new world of project building is waiting to open up to you.

Note: For a more in-depth discussion of surface-mount technology for electronics experimenters, you might want to pick up a copy of the author's Third Edition of *Electronic Project Design and Fabrication*, Macmillan Publishing Co., 445 Hutchinson Ave., Columbus, Ohio 43235. ■

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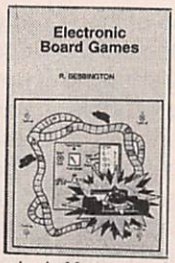

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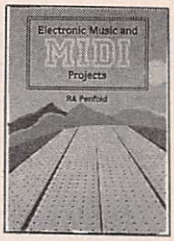

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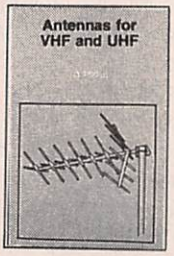

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MULTIMEDIA WATCH

(Continued from page 8)

Records. But I only had these discs a couple of months at the time of this writing (early September!). The New Grolier Multimedia Encyclopedia is a valuable multimedia reference source containing photos, charts, maps, video, animation, and more. With a low price of $149.95, it's a terrific investment for the whole family.

Everyone has heard of the *Guinness Book of Records*. That book has probably delivered the final verdict in more bets than any other. The answers to what's the biggest, the smallest, the fastest, and the tallest are all there. However, you might not be aware that the book is available on CD-ROM, as well. It's a whole new way of looking at world records. The 1994 Guinness Multimedia Disc of Records contains every single word, record, and picture from the book, plus video clips, audio, and sound effects, not to mention the search capabilities of CD-ROM. In addition, the CD-ROM also comes packaged with a paperback copy of the book. The disc/book combo has a list price of $49.95.

If you have an interest in armchair traveling through Medieval France and other places during the Middle Ages, then check out *MindQuest: Medieval France* from Blue Mountain Software. That $79.95 disc lets you take a multimedia tour of European architecture from the middle ages while listening to Medieval music. The disc also gives you access to maps, timelines, definitions, and narrated tours. Medieval France is the perfect break from your regular work.

If you or your business depends on making phone calls all around the country or the world, then three new discs from Pro CD will be of interest and great use to you. *Select Phone* is a 4-disc set that contains every telephone directory in the United States, business and residential, all linked to complete addresses. The information can be used as you see it, or it can be exported to other programs. *Free Phone* is AT&T's toll-free directory on one disc, and *Canada Phone* contains every business and residential white-page directory in Canada. *Euro Pages* is a similar directory on a single disc that contains listings for 150,000 European companies. That is great if you do business overseas. All of Pro CD's new discs can now run in Windows as well as DOS.

Multicom Publishing has a CD-ROM for everyone in the family. Mom will probably like *Better Homes and Gardens Healthy Cooking* with its detailed recipes, directions, and printable shopping lists. Ingredient proportions can be scaled automatically based on the number of servings. Mom should also like *Better Homes and Gardens Complete Guide to Gardening*, the comprehensive guide to gardening fundamentals. Dad might like those two discs, too! Children between the ages of 3 and 9 will love *Dandy Dinosaurs*, which includes stories, arts and crafts projects, and more. A cute stuffed dinosaur is also included.

A while back I looked at a *CD-ROMIX!* multimedia comic book from Davidson & Associates, *Freex #1*, the first story in the Freex series from Malibu Comics' Ultraverse line. I recently enjoyed two other CD-ROMIX's just as much as Freex. *Prime #1* is about a 13-year old boy-turned-hero who defends schoolgirls, fights crime, and more. *Hardcase #1* is about a super-human who gives up crime-fighting to pursue a movie career, and then confronts his past and returns to fighting crime. Those comic books are brought to life using brilliant graphics, real voices, visual effects, music, and sound effects. Each disc contains only one comic book, but each is well worth its list price of $24.95 as the discs really show off what multimedia is all about. Besides, I think these #1-in-the-series CD-ROMIX will be collector's items, so I'm even keeping the boxes intact.

If you're a baseball fan, and the 1994 strike didn't ruin your appetite for the game, you will not want to miss Microsoft's *Complete Baseball 94*. The history of the game, its teams, and over 1000 of its players, from the earliest days to the past season, are all presented in an entertaining and easy-to-use format. A full complement of player and team statistics from 1901 to 1993 will settle any argument in a hurry. There's even a trivia challenge with more than 900 questions of varying difficulty. Strike or no strike, that $79.95 title is a definite hit.

If you are interested in multimedia games, you without a doubt have already heard about *Myst* from Broderbund Software. Well, I finally got around to checking it out for myself, and I am happy to say that everything you've heard is true. The game is beautiful to look at, easy to play, and a breeze to install. Its leisurely pace will not, however, appeal to die-hard fans of action games. In short, you are deposited on a seemingly deserted island without a clue to your whereabouts or purpose. The story emerges in bits and pieces from clues left scattered about various locations. Just one hint: There is more to this game than first meets the eye. I've only spent a few hours with it, and I've barely scratched the surface. Fans of adventure games will become addicted in short order. Myst sells for about $55.

If you're into ham radio, then you might want to subscribe to AmSoft's *The World of Ham Radio* on CD-ROM for $99. Published three times a year, the disc includes over 750,000 new and previous call signs, making it easy to create mailing lists. The discs also include over 7000 ham-related programs.

To finish up this month I've got some software that's available only on floppy disk, but I think it deserves mention anyway. First, a couple of utilities for Word for Windows, *Doc-To-Help* and *Quicture*, both from WexTech Systems, Inc. I'm a big fan of Word for Windows, and those two utilities make it even more versatile. Doc-To-Help lets you create Windows on-line help using Word for Windows, and Quicture reduces the time required to load, scroll, print, and save Word for Windows documents that contain graphics.

Last but not least, *TIE Fighter* from LucasArts is a mind-boggling, Star Wars action game, but this time you work for the Dark Side, and your mission is to destroy the Rebel Alliance. TIE Fighter, the sequel to X-Wing, contains dazzling action graphics and hours of fun. The best action games still must be played from a hard drive, and TIE fighter is no exception. It is well worth the disk space, though. ■

WWV RECEIVER

(Continued from page 52)

signal germanium or Schottky units. Selecting two diodes with matched forward-bias characteristics is not absolutely necessary; however, don't mix completely different types of diodes in the mixer!

The CA3240 op-amp was specified because of its low cost and moderately low, input-noise characteristic; the alternative HA series units listed in the Parts List are preferred for their lower noise figures. The MC1458 and other "741" derivatives should be avoided. With a single RF-amplifier stage, the receiver is noise limited by the op-amp, so lowest-noise units are beneficial to the overall operation of the receiver.

As for component replacement and substitution, most passive components are not critical and can be replaced with close values. If you can't find the Zener diode, it can be simulated by connecting five 1N914's in series.

Transformer Winding. Transformer T1 is a home-made unit, consisting of 40 closely wound turns of #26 AWG enameled wire on a ¼-inch diameter air-core form, as shown in Fig. 4, with taps at 2½ and 10½ turns from each end; after each tap, the windings proceed in the same direction. Hot-melt glue can be used to secure the windings to the form. The coil does not require a tuning slug in the core.

Fig. 5 shows the assembly details for T2 (the mixer transformer). Shown electrically in Fig. 5A, T2 is wound on a ferrite bobbin taken from a subminiature 10.7-MHz IF transformer or detector coil universally used in older pocket, auto, and console FM radios. IF transformers are typically color-coded brown, green, or blue, and the detector coils are typically black or white. The 10.7-MHz detector coils are easily confused with 455-kHz transformers, which also use black and white as identifying codes. The internal arrangement of the detector coil differs from that of a 455-kHz transformer in that it has a single winding, while the 455-kHz unit has two.

Disassemble the transformer or coil, remove the tuning sleeve, the windings, and any tuning capacitor in the base. The bobbin is a dumb-bell shaped piece of ferrite material glued to the base. Lay out three 13 cm lengths of #32 to #38 AWG enameled wire in parallel. Wind the three wires 10 times around the bobbin as a set, as shown in Fig. 5B. Solder the wire ends to the base pins as shown in Fig. 5C.

The core permeability and the winding inductance are not critical as long as the winding acts as a transformer at 10 MHz with low inter-winding capacitance. The windings should not be glued within the bobbin.

Test. After completing the assembly, apply power to the circuit and check the voltage across Zener diode D3; the voltage across it should be between 3.0 and 3.6 volts. Connect a good ground to the receiver—a cold water pipe is preferred. Static should be heard through the speaker. Adjust trimmer capacitor C11 until a WWV signal is audible; then peak C11 for the best reception. The local-oscillator frequency will initially be offset from WWV, so you'll probably hear the beat note. Adjust trimmer capacitor C1 zero beat.

If a WWV signal is not heard, verify that the audio circuit is functioning; check the input of U1 pin 3 to U2 pin 3 with an audio signal injector, while listening to the receiver output. Check the local oscillator's operation using an oscilloscope, dip meter/monitor, or other frequency-test device, or listen for the 10-MHz, local-oscillator signal on another 10-MHz receiver.

If the audio amplifiers are functioning, but no signal is heard, verify the winding polarity of T2 and the winding order on T1. If you have a dip meter, use it to verify and set the resonant frequency of C11/T1 to 10 MHz. Check the receiver with a marker generator calibrated for 25-, 50-, or 100-kHz increments. If a signal is still not heard, wait a few hours and try again. Verify your ground connection at both ends—the ground is essential for the short antenna.

After the initial circuit test, it may be necessary to re-trim capacitor C11 for optimum reception. If C11 does need re-trimming, re-examine your antenna attachment to the case and see if you can't reduce the stray capacitance by increasing insulation width or separation. ■

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DX BEAM-AIMER

(Continued from page 42)

Lines 580–620 first determine the lengths of arcs F and E, even if they are in different north-south hemispheres. Similarly, lines 630–700 calculate the angle at the North Pole (point I) between the origin and the destination, taking into consideration their east-west locations. These calculations are also designed to define the smallest of two possible spherical triangles, since one triangle could go around the globe in a reverse direction!

The remainder of the program is concerned with solving for the spherical triangle between the North Pole, the origin and the destination, and then printing the results. The remark statements show the formulae used.

Lines 710–730 print the North Polar Angles, and then lines 740–820 do the calculation for the length of the arc D. The computer uses "radians" for the calculations. A radian equals 57.2958 degrees. Therefore, one degree equals 0.0174533 radians (1 divided by 57.2958.)

This conversion is shown in line 750 and is used in lines 770–810. The formula to calculate the COSine of arc D is shown in line 760, and used in line 820.

Now it is necessary to get the "inverse cosine," usually called the "arc-cosine," to convert the calculated variable D (actually COSine D) to an angle in radians. Some computers have the arccosine function in BASIC, but most don't, so a conversion formula is used in line 840, instead.

Line 860 converts the value of angle D from radians to the more familiar degrees, then line 890 calculates nautical miles by multiplying degrees by 60, since there are 60 nautical miles in one degree on a great circle. Line 910 converts nautical miles to statute miles (which are 1.1515 times nautical miles.) Lines 890 and 920 print the results on the screen.

Lines 930–1010 calculate the direction between the origin and destination, using the spherical trigonometry formula in line 940. Here again the arccosine formula is used to determine the angle G in radians, which is then converted to degrees by line 990. Line 1000 assures that the smaller of two possible triangles is used, and the direction from A to B, measured clockwise from north, is printed by line 1010. Line 1020 ends the program.

```
        *** BE SURE KEYBOARD IS IN CAPS-LOCK MODE! ***

                GREAT CIRCLE DISTANCE AND DIRECTION

        TO DETERMINE THE SHORTEST DISTANCE FROM POINT A TO
        POINT B, AND THE DIRECTION FROM A TO B, ENTER THE
        LATITUDE AND LONGITUDE IN DECIMAL DEGREES OF EACH POINT.
        THESE CAN BE FOUND FROM A MAP, GLOBE OR ENCYCLOPEDIA.

        WHEN READY TO PROCEED, PRESS ENTER?



        *** BE SURE KEYBOARD IS IN CAPS-LOCK MODE! ***

POINT A NAME ? LOS ANGELES
POINT B NAME ? ZANZIBAR
IS ZANZIBAR EAST OR WEST OF LOS ANGELES (E OR W)? E

LATITUDE OF LOS ANGELES? 34
NORTH OR SOUTH (N OR S)? N
LONGITUDE OF LOS ANGELES? 118.5
EAST OR WEST (E OR W)? W

LATITUDE OF ZANZIBAR? 8
NORTH OR SOUTH (N OR S)? S
LONGITUDE OF ZANZIBAR? 40
EAST OR WEST (E OR W)? E


LOS ANGELES IS 34 DEGREES NORTH AND 118.5 DEGREES WEST
ZANZIBAR IS 8 DEGREES SOUTH AND 40 DEGREES EAST
ZANZIBAR IS EAST OF LOS ANGELES

NORTH POLAR ANGLE TO POINT A (LOS ANGELES) IS 56 DEGREES.
NORTH POLAR ANGLE TO POINT B (ZANZIBAR) IS 98 DEGREES.
NORTH POLAR ANGLE BETWEEN POINTS IS 158.5 DEGREES.

DISTANCE A-B IS 8839.028 NAUTICAL MILES ( 147.3171 DEGREES).
DISTANCE A-B IS 10178.14 STATUTE MILES.

DIRECTION A-B IS 42.22964 DEGREES CLOCKWISE FROM NORTH.
```

Fig. 2. The program begins by presenting a brief overview of how to enter location data. Then it requests the data, processes it, and returns its results.

Modifications. If you are a true perfectionist, you'll probably want to modify the program to accept input in degrees, minutes, and seconds rather than decimal degrees. Also, you might wish to add a DATA statement to declare typical locations and their latitudes and longitudes, so that you can type in the city name and have the program look for the coordinates. To assist you, Table 2 shows the approximate geographic coordinates of some well-known cities, and typical results from using this program. Bear in mind that different types of BASIC will calculate slightly different results beyond one or two decimal places.

For the convenience of readers who would like to use this program on an IBM PC or compatible, the author is willing to supply a disk with both DX-BEAM.BAS (GWBASIC source code) and DXBEAM.EXE (executable from DOS) for $5, postpaid in the US, $7 for foreign orders. Order from Fred Blechman, 7217 Bernadine Ave., West Hills, CA 91307. Specify 5.25- or 3.5-inch disk. ■

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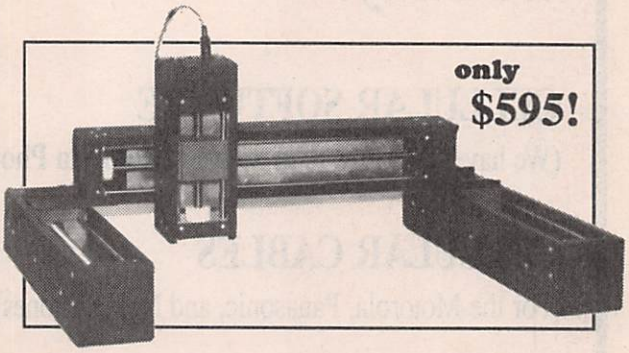

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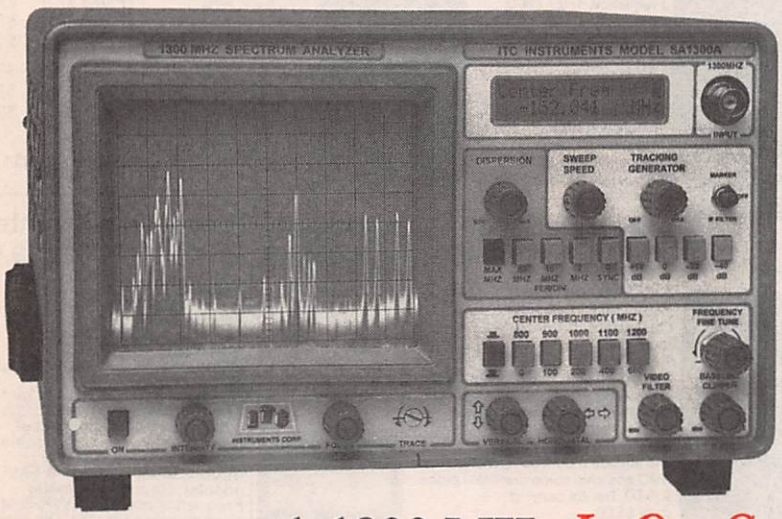

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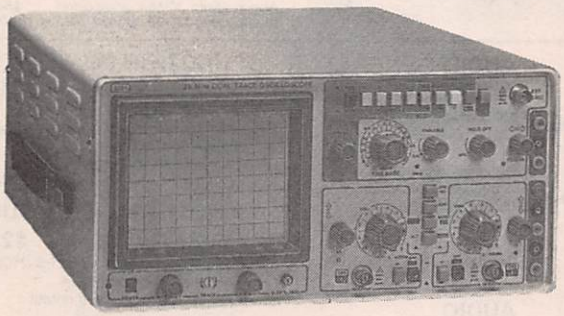

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model SD3315

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6" Very Bright 12kV CRT
Rise Time < 8 nS
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Volt, Amp, Ohm
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Capacitance: 1pF-200 F
Frequency: 1Hz-1MHz
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Inductance: 0.1µH-1000H
Capacitance:0.1pF-10,000µF
Impedance:1mΩ-10MΩ
0.7% basic accuracy
Dissipation factor & Q factor
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Statistics, tolerance,
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SMD and chip component test probe $25.00

LCR Meter 814 $189.95

Best Resolution LCR

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Resistance: 1mΩ-20MΩ
1% basic accuracy
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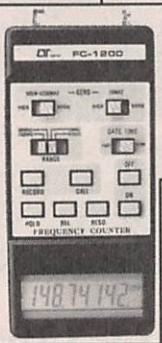

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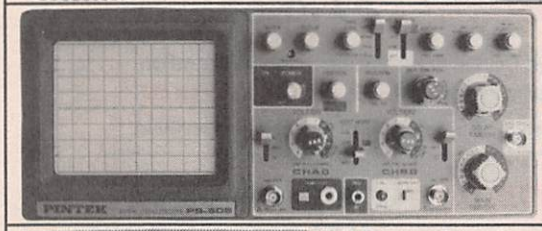

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Scope Probe: 60MHz x1, x10 $13, 100MHz x1, x10 $22

20 MHz Digital Storage Oscilloscope DS-203 $729.95

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Sampling rate: 10 M sample /sec
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Expanded Timebase 10ms/div - 0.5 s/div
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Plotter Control
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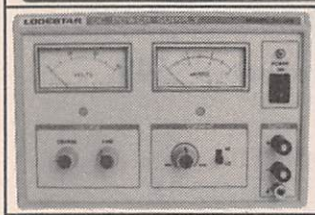

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100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz
AM modulation
Audio output 1 kHz, 1 Vrms

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Generates RF signal same as SG-4160B
Frequency counter 1Hz - 150 MHz for internal and external source
Sensitivity <50mV

AUDIO GENERATOR AG-2601A $119.00

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0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
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0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz for internal and external sources
Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
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1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/ COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

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62 Scan Banks, 16 Search Banks, 35 Channels per second. Patented Computer control for logging and spectrum display. AM, NFM, WFM, & BFO for CW/SSB. Priority bank, delay/hold and selectable search. Cell Lock Permanent memory. DC or AC with adaptors. Mtng Brkt & Antenna included. Size: 2 1/4H x 5 5/8W x 6 1/2D. Wt. 1lb. Fax fact #305

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Three new Bearcat units offer expanded coverage and more memory than before. The 890 offers 200 channels, base/mobile operation, VFO tuning, service search, weather alert, search and store, and more. The 2500 hand held has 400 channels, fast scan and more. The Bearcat 8500 has 500 channels in 20 banks, VFO, auto store, alpha numeric display, 10 priority channels, aux tape output jacks, and coverage to 1.3 Gigahertz.

Bearcat 2500XLTA hand held.....$349.95
Bearcat 8500XLTC mobile.....$389.95
Bearcat 890XLTB mobile.....$259.95
25-1300MHz, 500 ch. in 8500, 400 in 2500. 890 has 200 ch.& 29-956MHz. All cell locked. Features include turbo scan, VFO, search and store, Priority, LCD display, and more. Fax Facts474,475,476

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Police & CB
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Scans police pre-programmed by state channel *plus* the CB channel of your choice. Also has Mobile Repeater and Weather. Extra cost option of CB and laser detectors built in. Compact size allows for dash or visor mounting. Mtng hardware and power connectors included. Size: 5 5/8 x 4 7/8 x 1 3/4. Wt: 1.5lbs. Fax fact #580

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Bearcat 350A 50 Ch H/L/U..... $119.95
Bearcat 560XLJ 16 Ch H/L/U..... $ 89.95
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Bearcat T2 state/state scan..... $144.95

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Trident TR2400: 100KHz to 2060MHz. Ten scan banks of 100 channels each, ten search banks. Tuning increments as low as 1KHz. Beat Freq. Oscillator for SSB and CW modes. Search lockout and store. VFO tuning knob. Permanent memory. Bank lock and linking. Attenuator switch. Backlit LCD. 1 Yr Warranty. AM/NFM/WFM. Selectable increments . Delay, Hold, Priority. 5 7/8H x 1 1/2D x 2W. Wt 14 oz. **$499.00**

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Sangean ATS-808..... $179.95
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Sangean ATS-800..... $89.95
Grundig YB400..... $219.00
Grundig Satelit 700..... $399.00

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Bearcat 200XLTN
$209.95 200 Channels 800 MHz

Ten scan banks plus search. Covers29-54, 118-174, 406-512 and 806-956MHz (with cell lock). Featuresscan, search, delay, 10 priorities, mem backup, lockout, WX search, keylock. Includes NiCad & Chrgr. Size: 1 3/8 x 2 11/16 x 7 1/2.

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Bearcat 150XLT 100Ch H/L/U/8..... $199.95
Bearcat 220XLTJ 200 Ch H/L/U/8.... $249.95
Coverage of above hand helds is: 29-54, 136-174, 406-512, and 800MHz band as indicated. Fax facts #475

Table Top Scanners

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Bearcat 142XLM 10Ch H/L/U..... $ 73.95
Bearcat 147XLJ 16 Ch H/L/U..... $ 89.95
Bearcat 172XM 20Ch H/L/U/Air..... $124.95
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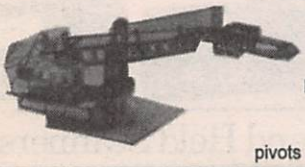

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$75.00
3 fully regulated supplies; 1.5-15V @ 1A, -1.5 to -15V @ 1A or 3-30V @ 1A & 5V @ 3A **Kit XP-620K $49.95**

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$79.95
Four supplies in one unit; 2-20V @ 2.5A, 5V @ 3A, -5V @ .5A and 12V @ 1A. All regulated and short protected

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Connect 2 or more in parallel

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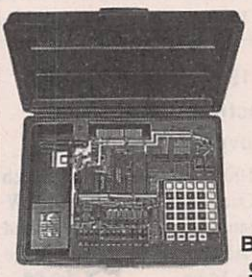

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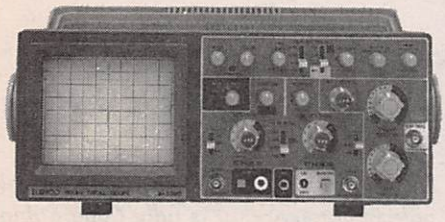


60MHz

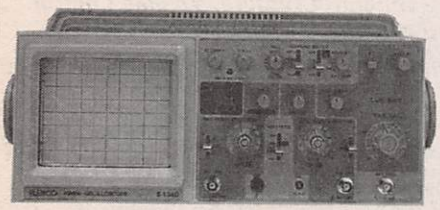
S-1360 $775

Delayed Sweep

S-1365 $849

Cursor Readout

- Voltage, Time
- Frequency differences displayed on CRT



40MHz

S-1340 $495

2- Channel

S-1345 $575

Delayed Sweep

- Beam Find
- Component Tester

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S-1325 $349

2- Channel

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Delayed Sweep

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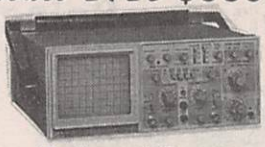
Dependable Equipment at Affordable Prices

B+K 20MHz

2 Channel

Model 2120 $389.00



Delayed Sweep

Model 2125 $539.95

40MHz DUAL -TRACE

Model 1541B

$749.95

- 1mV/div sensitivity
- Video sync separators
- Z axis input
- Single sweep
- V mode-displays 2 signals unrelated in frequency

60MHz DUAL-TRACE

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$949.95

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- Sweep to 5ns/div
- Dual time base
- Signal delay line
- Component tester
- V mode-displays 2 signals unrelated in frequency

100MHz THREE-TRACE

Model 2190

$1,379.95

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- Sweeps to 2ns/div
- Dual time base
- Signal delay line
- 19kV accelaerating voltage
- Calibrated delay time multiplier

20MHz ANALOG with DIGITAL STORAGE

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- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2k memory per channel
- 20MHz equivalent time sampling

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V-523 - 50MHz, Delayed Sweep	$995.00
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V-665A - 60MHz, DT, w/cursor	$1,449.00
V-1060 - 100MHz, Dual Trace	$1,549.00
V-1065A - 100MHz, DT, w/cursor	$1,695.00
V-1085 - 100MHz, QT, w/cursor	$2,125.00
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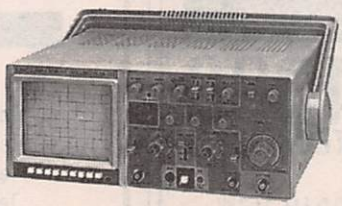
Elenco DS-203 20MHz, 10MS/s Digital Storage Oscilloscope



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2K Word Per Channel • Plotter Output 8 Bit Vert. Resolution • 2048 Pts Hor. Resolution • Much More.....

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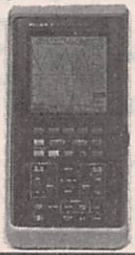

Model 93 - $1,225
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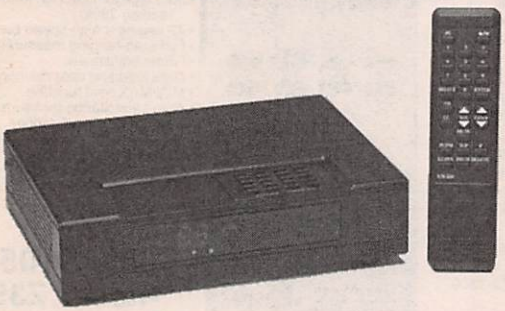

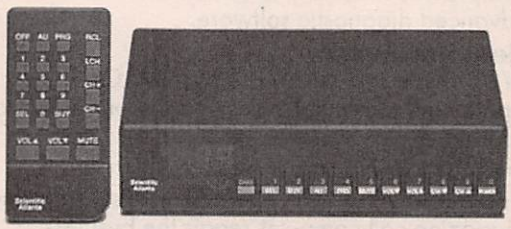

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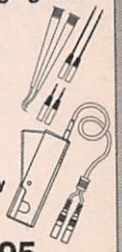

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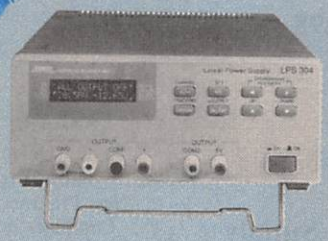

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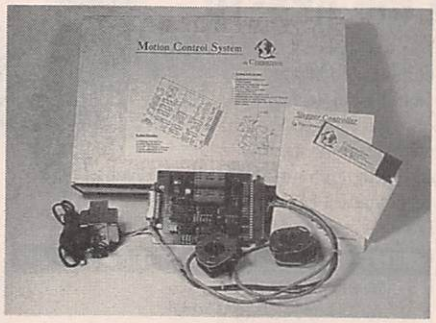

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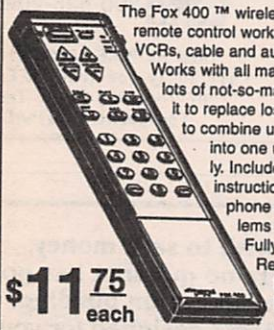

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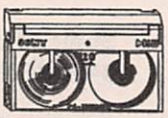

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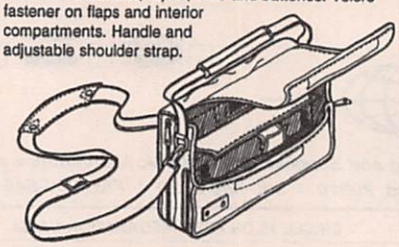

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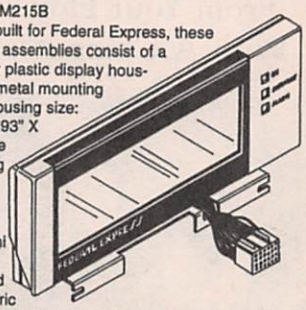

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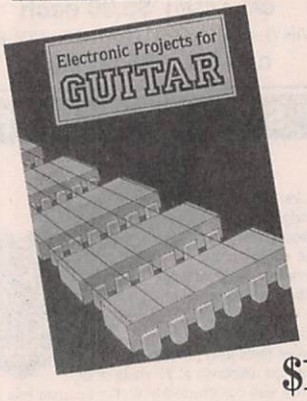

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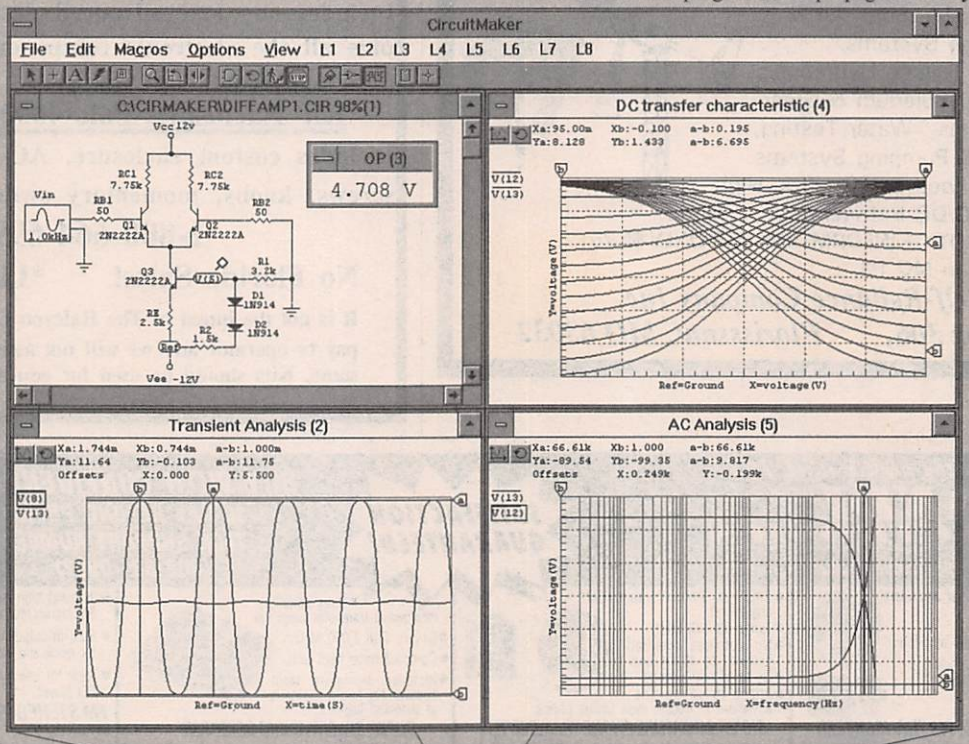
CircuitMaker has an exclusive Trace feature where the state of every node is indicated in color as the simulation runs. You can monitor as many waveforms as your screen will allow, set edge or level breakpoints for analysis, and interactively see the state of any node by touching the logic probe to it. The data sequencer provides 1024 words of pattern data. Additional digital instruments include ASCII and HEX input keys and an ASCII display. CircuitMaker includes tri-state devices and devices have programmable propagation delays.

Electronic Workbench has no interactive logic probe or Trace capability and no Hex or ASCII keys. Their "word generator" is limited to 16 words. EWB does not have tri-state devices and digital devices do not have programmable propagation delays.



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Comparison based on CircuitMaker 2.0 for Windows and Electronics Workbench 3.0 for Windows. All product and company names are trademarks of their respective owners.

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- Dial your phone from anywhere and listen to the sounds inside your home.
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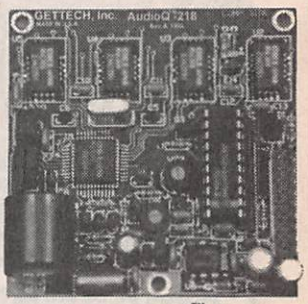

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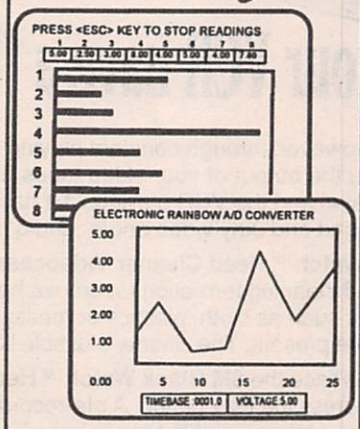

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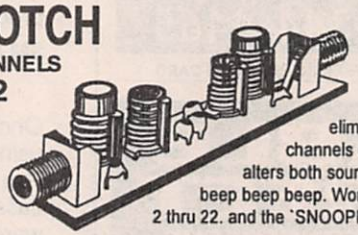

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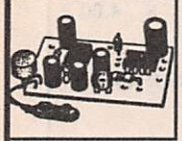

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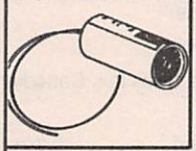

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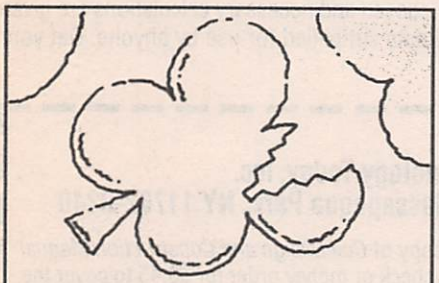

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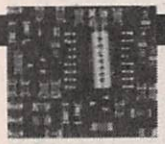

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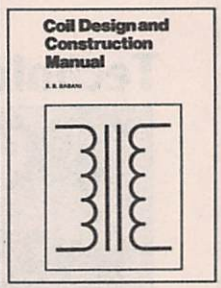

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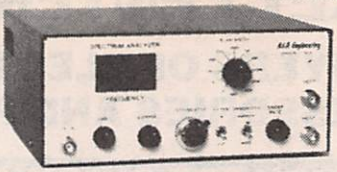

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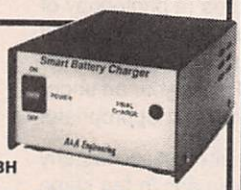

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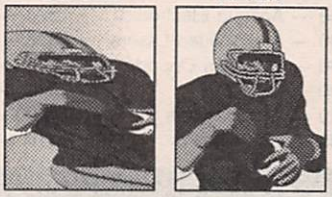

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INSTRUCTION FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.00per word. Minimum charge is $15.00 per ad per insertion (15 words). Any words that you want set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT

All classified advertising in the **PE Market Center** is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

DEADLINES

Ads received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March, 1995 issue that is on sale January 17. The PE Market Center is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

AD RATES: $1.00 per word, Minimum $15.00.

Send your ads with payment to:
Popular Electronics Market Center, 500-B Bi-County Blvd. Farmingdale, NY 11735

CATEGORIES

100 — Antique Electronics
130 — Audio-Video-Lasers
160 — Business Opportunities
190 — Cable TV
210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
300 — Computer Hardware
330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
480 — Miscellaneous Electronics For Sale
510 — Miscellaneous Electronics Wanted
540 — Music & Accessories
570 — Plans-Kits-Schematics
600 — Publications
630 — Repairs-Services
660 — Satellite Equipment
690 — Security
710 — Telephone
720 — Test Equipment

CLASSIFIED AD COPY ORDER FORM

Ad No. 1—Place this ad in Category # _____

1 - $15.00	2 - $15.00	3 - $15.00	4 - $15.00
5 - $15.00	6 - $15.00	7 - $15.00	8 - $15.00
9 - $15.00	10 - $15.00	11 - $15.00	12 - $15.00
13 - $15.00	14 - $15.00	15 - $15.00	16 - $16.00
17 - $17.00	18 - $18.00	19 - $19.00	20 - $20.00
21 - $21.00	22 - $22.00	23 - $23.00	24 - $24.00
25 - $25.00	26 - $26.00	27 - $27.00	28 - $28.00
29 - $29.00	30 - $30.00	31 - $31.00	32 - $32.00
33 - $33.00	34 - $34.00	35 - $35.00	36 - $36.00
37 - $37.00	38 - $38.00	39 - $39.00	40 - $40.00

Ad No 1—Total words _____ × $1.00 per word = $ _____

All Caps words _____ × .20 per word = $ _____

Bold words _____ × .20 per word = $ _____

Bold Cap words _____ × .40 per word = $ _____

TOTAL COST OF AD No. 1 $ _____

Total classified ad Payment $ _____ enclosed.

[ ] Check [ ] MasterCharge [ ] Visa ($15.00 minimum credit card order)

Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Expiration Date _ _ / _ _

Signature _____

Name _____ Phone _____

Address _____ City State Zip _____

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CELLPHONE MODIFICATIONS

See our Catalog for our infamous cellphone modification guide ($69) - detailed, comprehensive, covers all makes - 10 times more info than competitor's *guides*). (Do Special Projects (below) for up-to-date hardware/software).

SPECIAL PROJECTS

We design, build, repair, modify, maintain and-or consult on any device, system, process or project - electrical, electronic, computer, phone, mechanical, optical, automotive. Invention prototyping. Confidentiality guaranteed. Describe and include $25 pre-engineering fee (does not obligate you). Time and cost estimates in 7-10 days.

VOICE MAIL HACKING

How Voice Mail Box (VMB) systems are used and the specific ways they are hacked. Includes ASPEN, MESSAGE CENTER, BIX, GENESIS, EZ, SYDNEY, PHONE MAIL, AUDIX, CINDY, CENTAGRAM, SPERRY LINK, RSVP, etc. Absolutely required for all users, sysops and security personnel! $29.

PBX HACKING

1,000s of PBXs are hacked to the tune of $ Billions/yr! While *VOICE MAIL HACKING* details how VMSs are hacked for *phun* and profit - including VMS methods for hacking PBXs themselves - *PBX HACKING* addresses ALL issues relating to PBX hacking, including countermeasures! Can your business or agency afford a $90,000 phone fraud loss (the average loss due to hacked PBXs)? As described in Forbes Magazine. $39

PHREAKING CALLER ID & ANI

Details on how they work and dozens of effective ways of defeating Caller ID, ANI, *69, *57, and Call Blocking and *67. Also describes Caller ID, Orange, Beige, Cheese and CF Boxes, ESS, SS7, E-911, various CLASS services, CNA, NON PUB DA, CAMA, DNR, 800-ECR, Diverters, LD Extenders, Centrex - more. $29.

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As designed by Phone Phreaks! 15 phone color boxes described. Dozens of circuits, simulator programs. Plus call-forwarding, conferencing, phreak history, 50 useful and legal phone circuit plans - more. $29.

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COMPUTER PHREAKING

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AUTOMATIC TELLER MACHINES

ATM crimes, abuses, vulnerabilities and defeats exposed! 100+ methods detailed, include: Physical, Reg. E, cipher, PIN compromise, card counterfeiting, magnetic stripe, false front, TEMPEST, Van Eck, tapping, spoofing, inside job, super-cool, vibration, pulse, high voltage - others. Case histories, law, countermeasures, detailed security checklist, labeled internal photos, figures. ATMs contain up to $250,000 in cash! Recent $350,000 ATM crime spree still unsolved! $39.

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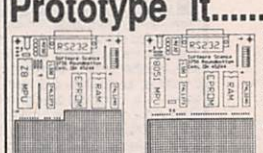
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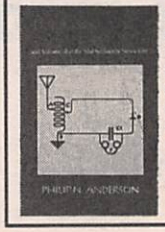
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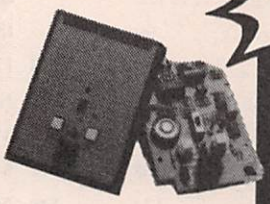

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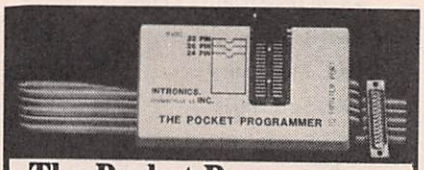

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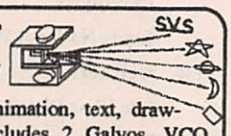
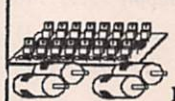


This kit displays animation, text, drawings, & music! Includes 2 Galvos, VCO, Computer Interface, Manual & Software listing. Works from parallel printer port.



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21	33	45	57	69	81	93	105	117	129	141	153	165	177
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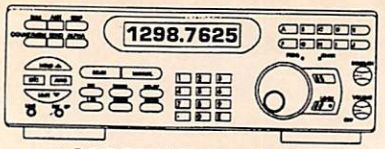

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By Charles Anton

Do you wonder why car alarms have countless features to protect your car, but nothing to protect you? After all, what's more important your car or the safety of you and your family?

Now there is a car alarm that *will protect you and your family.* It is the first of its kind to focus on the safety of the vehicle owner as well as the vehicle itself.

Protect yourself. It all begins with the panic button. Imagine you're walking to your car at night and a person approaches. Pushing the panic button on your transmitter lets your car come alive with a shrieking siren and flashing headlights. While the panic alarms of other vehicle security systems have a range of 100 feet, the Smart Alarm's panic alarm lets you call for help or scare away potential attackers from up to 400 feet!

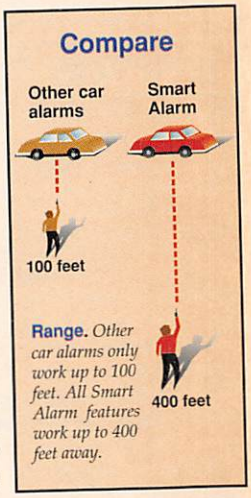
Exclusive feature. Unlike other car alarm systems that begin and end their focus on personal protection with the panic alarm, that's just the beginning of the Smart Alarm. In addition to the panic alarm, the Smart Alarm also has a car finder feature. You'll never again have to wander around a dark and dangerous parking lot searching for your car. You will be able to know where your car is from anywhere within 400 feet by flashing its lights and briefly sounding the siren. You can activate and deactivate your car's headlights by remote control to light your way in a dark driveway or parking lot.

Carjacking. The Smart Alarm also addresses a growing hazard for today's motorists—carjacking. It's alarming how often drivers are hurt in their cars because they refuse to give them up to carjackers. Because of its anti-carjacking device, the Smart Alarm allows you to safely retain your car when confronted by a carjacker. This is made possible by a delayed panic alarm.

All you do is give up your car and activate the delayed panic alarm. When the assailant has reached a safe distance and is no longer a threat to you, a deafening 120dB siren and flashing lights will force him to flee your car, letting you recover it safely.

Vehicle protection. Smart Alarm's current sensor triggers the siren if the trunk or any of the doors are opened while the alarm is armed. To supplement the current sensor, a shock sensor triggers the siren when it detects a blow to your car. Together, these sensors provide your car with blanket protection.

An adjustable shock sensor prevents the siren from being triggered, eliminating false alarms. You can also adjust the shock sensor and the siren with your remote control at any time you choose. The siren's tone and volume can be adjusted to six separate tones. As a result, you'll never confuse it with any other alarm. You can also customize the siren, making it louder in noisy neighborhoods and quieter in more peaceful neighborhoods.



Risk-free home trial. With the Smart Alarm, you get a complete "No Questions Asked" 30-day money-back guarantee. If it's not everything we say, just return it for a full refund. The Smart Alarm is also backed by a two-year warranty. Your order will be shipped UPS in seven to ten working days.

The Smart Alarm Car Alarm..... $99 $9 S&H

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What makes Smart Alarm better?

- **Range.** Most car alarm features only work up to 100 feet away—all Smart Alarm features work up to 400 feet away.
- **Panic button.** Smart Alarm lets you call for help or scare away potential troublemakers by controlling a piercing alarm and your car's headlights.
- **Car finder.** Your car will be able to let you know where it is by flashing it's lights and briefly sounding the siren.
- **Carjacking.** Its delayed panic alarm allows you to safely prevent theft of your car when confronted by a carjacker.
- **Easy installation.** Other car alarms are complicated or cost hundreds of dollars to install. Smart Alarm is inexpensive, and you can install it in just minutes.

Smart Alarm is the first car alarm that will protect you and your family.

Easy installation. *Installing the Smart Alarm requires no fumbling with wires. Special Plug-In Connectors let you install the Smart Alarm without a single wire-cutter! Simply unplug the headlight connector, plug in the Smart Alarm connector, and then plug the headlight connector to the Smart Alarm. Connect the Smart Alarm to the battery cable with the special clip. In minutes, you and your car can enjoy complete 24-hour protection. Away from your car, you'll feel safer knowing that your car is protected! Near your car, you'll feel safer knowing that you are protected!*